HEALTH

IN RELATION TO

CIVIC LIFE

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VOLUME VIII.

HEALTH IN RELATION TO CIVIC LI

CONFERENCES.

DOMESTIC SANITATION.

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CONFERENCES.

TRANSACTIONS OF THE

CONFERENCE ON DOMESTIC SANITATI

IN URBAN AND RURAL DISTRICTS.

INDUSTRIAL DISEASES. THE SPREAD OF INFECTIOUS DISEASES.
NOTIFICATION OF INFECTIOUS DISEASES.
THE DISPOSAL OF THE DEAD. CREMATION.

ORGANIZED AND CONDUCTED BY

THE SOCIETY OF MEDICAL OFFICERS OF HEALTH; THE SANITARY INSTI
OF GREAT BRITAIN; THE PARKES MUSEUM OF HYGIENE.

JUNE 9 TO 14, 1884.

CONFERENCE ON SANITARY SUBJECTS.

JUNE 9TH TO JUNE 14TH, 1884.

PREFATORY NOTE.

THIS was the Conference of the Society of Medical Officers of Health, the Sanitary Institute of Great Britain, and the Parkes Museum of Hygiene, and was organized by a Joint-Committee of the three societies at the request of the Executive Council of the International Health Exhibition.

The Joint-Committee was constituted as follows:—

T. ORME DUDFIELD, M.D., *Chairman*, T. SYER BRISTOWE, M.D., F.R.S. A. WYNTER BLYTH, M.R.C.S., F.C.S.	*Representing the Society of Medical Officers of Health.*
ALFRED CARPENTER, M.D., J.P. W. H. CORFIELD, M.A., M.D. ERNEST TURNER, F.R.I.B.A.	*Representing the Sanitary Institute of Great Britain.*
DOUGLAS GALTON, Capt. R.E., C.B., F.R.S. ROGERS FIELD, M. Inst. C.E., B.A. LOUIS PARKES, M.D., *Secretary.*	*Representing the Parkes Museum of Hygiene.*

The Papers read were as follows:—

Monday, June 9th. "The Domestic Sanitary Arrangements of the Metropolitan Poor. By JOHN W. TRIPE, M.D., Medical Officer of Health for Hackney. "The Improvement of the Sanitary Arrangements of Metropolitan Houses." By ERNEST TURNER, F.R.I.B.A. *Chairman*, T. ORME DUDFIELD, Esq., M.D., President of the Society of Medical Officers of Health, Medical Officer of Health for Kensington.

Tuesday, June 10th. "Domestic Sanitation in Rural Districts." By GEORGE WILSON, M.A., M.D., Medical Officer of Health for the Mid-Warwick District. "Sanitary Houses for the Working Classes in Urban Districts." By PERCY BOULNOIS, M. Inst. C.E., Borough Engineer, Portsmouth. *Chairman*, Captain DOUGLAS GALTON, C.B., F.R.S., Chairman of Council, Parkes Museum of Hygiene.

Wednesday, June 11th. "Industrial Diseases." By JOHN SYER BRISTOWE, M.D., F.R.S., Medical Officer of Health for Camberwell. *Chairman*, EDWIN CHADWICK, Esq., C.B., Vice-President of the Sanitary Institute of Great Britain (in the absence, through illness, of His Grace the DUKE OF NORTHUMBERLAND, D.C.L., LL.D., President of the Institute).

Thursday, June 12th. "How Infectious Diseases are Spread." By W. H. CORFIELD, M.A., M.D., Medical Officer of Health for St. George's, Hanover Square. "Cow's Milk as a Vehicle of Infectious and Epidemic Disease to the Community, with suggestions for the more effectual Prevention of such Outbreaks." By W. N. THURSFIELD, M.D., Medical Officer of Health, Shropshire Comb. District. *Chairman*, Dr. ALFRED CARPENTER, J.P., Chairman of Council, Sanitary Institute of Great Britain.

Friday, June 13th. "The Right of the State to enforce Notification of Infectious Diseases, and the best method of doing it." By ALFRED CARPENTER, M.D., J.P. "The Notification of Infectious Diseases, its Importance and its Difficulties." By ALFRED HILL, M.D., Medical Officer of Health for Birmingham. *Chairman*, The Right Hon. EARL FORTESCUE, Vice-President of the Parkes Museum of Hygiene.

Saturday, June 14th. "The Disposal of the Dead." By A. WYNTER BLYTH, M.R.C.S., Medical Officer of Health for St. Marylebone. "Cremation." By W. EASSIE, C.E. *Chairman*, Sir JAMES MCGAREL HOGG, Bart., M.P., K.C.B., Chairman of the Metropolitan Board of Works.

The Conferences were largely attended and the discussions on the several Papers well sustained: the following gentlemen taking part in them:—

ACLAND, Sir HENRY, K.C.B., M.D., Regius Professor of Medicine, Oxford.
ACLAND, Sir T. DYKE, Bart., M.P.
ANDERSON, Dr. A.
ARMISTEAD, Dr. W., Medical Officer of Health, Cambridgeshire.
ARMSTRONG, Mr. H. E., Medical Officer of Health, Newcastle-on-Tyne.
BARTLETT, Dr. H. C., Ph.D., F.C.S.
BAILY, Mr. J., Secretary to the Vigilance Committee.
BERNAYS, Dr.
BLASHILL, Mr. T., F.R.I.B.A.
BLYTH, Mr. A. WYNTER, M.R.C.S., Medical Officer of Health, St. Marylebone.
BUCKINGHAM AND CHANDOS, His Grace the Duke of, K.G.
BURNS, Mr. J. CLELAND, Chairman of the Glasgow Charity Organization Society.
CAMERON, Dr. CHARLES, M.P.
CARPENTER, Dr. A., J.P.
CARTER, Dr. W., Medical Officer of Health, West Derby.
CHADWICK, Mr. EDWIN, C.B.
CORFIELD, Professor W. H., M.A., M.D., Medical Officer of Health, St. George's, Hanover Square.
DE CHAUMONT, Professor F., M.D., F.R.S., Army Medical School, Netley.
DIXON, Dr. JOHN, Medical Officer of Health, Bermondsey.
DUDFIELD, Dr. T. ORME, Medical Officer of Health, Kensington.
FARQUHARSON, Dr. ROBERT, M.P.
FIELD, Mr. ROGERS, B.A., M. Inst. C.E.
FLEMING, Professor, Principal Veterinary Surgeon to the Army.
FORTESCUE, The Right Hon. Earl.
GALTON, Captain DOUGLAS, C.B., F.R.S.
GIBBON, Mr. SEPT., Medical Officer of Health, Holborn.
GREENHOW, Dr. E. HEADLAM, F.R.S.
HARDY, Mr. NELSON, F.R.C.S.Ed., Dulwich.
HODGSON, Mr.
HOGG, Sir J. McGAREL, K.C.B., M.P., Chairman of the Metropolitan Board of Works.
JACOB, Mr. E. LONG, Medical Officer of Health, Surrey Combined District.
LAMBERT, Rev. BROOKE, Vicar of Greenwich.
LIGGINS, Mr.
MAHOMED, Dr. F., Physician to the London Fever Hospital.
MORGAN, Dr.

MURPHY, Mr. SHIRLEY, M.R.C.S., Medical Officer of Health, Islington.
NANSON, Mr. TOM.
NUNN, Mr. PHILIP.
OGLE, Dr. WILLIAM, Superintendent of Statistics, General Register Office.
ORD, Dr. W. MILLER, F.R.C.P.
PRIESTLEY, Dr. W. O., F.R.C.P.
PRINGLE, Dr. ROBERT, Surgeon-Major, Bengal Army.
RAWLINSON, Sir ROBERT, C.B., Chief Inspector, Local Government Board.
ROBINS, Mr. E. C., F.R.I.B.A.
SAUNDERS, Dr. SEDGWICK, Medical Officer of Health, Herts and Middlesex Combined District.
SLATER, Mr. JOHN.
SMITH, Mr.
TAAFFE, Dr. R., Medical Officer of Health, Brighton.
THURSFIELD, Dr. W. N., Medical Officer of Health, Shropshire Combined Sanitary District.
VACHER, Dr. FRANCIS, Medical Officer of Health, Birkenhead.
WALFORD, Dr.
WELLS, Sir SPENCER, Bart., F.R.C.S.
WEST, Dr. CHARLES, F.R.C.P.
WILSON, Dr. GEORGE, M.A., Medical Officer of Health, Mid-Warwick.
WOODFORDE, Dr. W., Medical Officer of Health, Berks Combined District.
YOUNG, Mr. W., Secretary to Society for Abolition of Compulsory Vaccination.

Conference on Monday, June 9th, 1884.

1. "*The Domestic Sanitary Arrangements of the Metropolitan Poor.*" By JOHN W. TRIPE, M.D., M.R.C.P., Ed., &c.
2. "*The Improvement of the Sanitary Arrangements of Metropolitan Houses.*" By ERNEST TURNER, F.R.I.B.A.

Chairman:—

T. ORME DUDFIELD, Esq., M.D.

Chairman of the Conference Joint-Committee; President of the Society of Medical Officers of Health; Medical Officer of Health for Kensington, &c.

THE CHAIRMAN, in opening the proceedings, stated that the Conference had been organised, at the request of the Executive Council of the Health Exhibition, by the Parkes Museum of Hygiene, the Sanitary Institute of Great Britain, and the Society of Medical Officers of Health. It was intended, originally, that each society should have a Conference of its own, managed by its own council, but it appearing probable that the subjects to be dealt with by the three societies—which were all working on similar lines—might overlap, it was thought desirable, by the Executive Council, that the societies should amalgamate for the purpose of holding a Conference in common. A

Joint-Committee, therefore, had been appointed to make the necessary arrangements, and he ventured to hope that the programme drawn up, and which was in the hands of most of those present, would be found sufficiently interesting, embracing as it did many subjects of considerable importance to sanitarians and to the public generally, whether in town or country. After briefly referring to the subjects of the papers to be read on the six days over which the Conference would be continued, and to the special qualifications of Dr. Tripe and Mr. Ernest Turner to deal with the subject assigned to them, and with which they would deal, the one from the medical and the other from the architectural point of view, the Chairman called upon Dr. Tripe to read his paper.

THE DOMESTIC SANITARY ARRANGEMENTS OF THE METROPOLITAN POOR.

By JOHN W. TRIPE, M.D., M.R.C.P., Ed., &c.

WHEN I was requested to read a brief Paper on this well-worn subject in conjunction with Mr. Ernest Turner, the first question which suggested itself to me was, Who are the poor concerning whom I have to address you? The word embraces a very great variety, I may say not only of persons but of classes; not merely the two great classes of the deserving and the undeserving poor, that is to say, (a) those who are poor from the force of circumstances over which they have no control, and (b) those who are poor from indulgence in vice, and even crime, but also a multitude of others who obtain an honest living as hawkers, costermongers, needle-women, matchbox makers, workers in manufactories, and others. I do not, however, propose to mention the domestic arrangements of any particular class, but to take the word "poor" in its broadest

sense as including all those who live in very small houses containing two or three rooms, or in tenement houses when they occupy perhaps only one, it may be two, or at the most three rooms, according to the size of their families. The houses in which many of them live are those to which "Regulations," made under the 35th Section of the Sanitary Act will apply, and differ very much in various parts of London, some being very old with low ceilings, imperfect means of ventilation, rotten floors and staircases; and are also dirty, dark, and generally dilapidated. The sanitary arrangements usually correspond with the houses; the water-closets being dark, foul smelling; the water supply apparatus frequently defective, the supply generally insufficient; the cisterns dirty, being rarely cleaned out; the dustbins frequently broken and full, containing offensive refuse, even excrement, so that it is dangerous to empty them. Houses in this state are frequently occupied by the residuum, many of whom are disgustingly filthy and destructive in their habits. I have seen fairly good sanitary waterclosets so misused as to convert them in a very short time into the most filthy places it is possible to conceive. Persons of this class can scarcely be said to have any domestic sanitary arrangements whatever; they inhabit certain streets and courts forming colonies, and can scarcely be reformed, except by breaking up and dispersing them amongst a better class, and by repeated appeals being made to their feelings by district visitors and others. The word "residuum" is now generally used to distinguish the lowest classes who have no definite occupation by which to obtain a livelihood.

There is another kind of house, with better sanitary arrangements, much occupied by the poor, viz., that containing five or six rooms, in which two or more families dwell, with rather low ceilings, fairly good sanitary appliances, although generally more or less dirty, but rarely, except when occupied by the residuum, so dirty and dilapidated as the others. To houses such as these the enforcement of the Regulations are of great service, as

there is comparatively little difficulty in getting the rooms and passages whitewashed and coloured once a year, and in obtaining fairly good water-closet accommodation, paving and drainage of the yards, and in keeping the water-supply apparatus in good order. The inhabitants of houses of this class, however, often keep poultry, rabbits, &c., in their yards, which is undoubtedly an insanitary arrangement, and should always be prevented if possible.

As very many persons may not understand the powers given to the Local Sanitary Authorities or the subjects on which Regulations may be made, I will state that by the provisions of the Sanitary Act, 1866, Section 35, the Local Government Board is empowered, on the application of a Nuisance Authority, by notice to be published in the *London Gazette*, to "declare the following Enactments to be in force in the district of such Nuisance Authority, and from and after the publication of such notice the Nuisance Authority shall be empowered to make Regulations for the following matters—that is to say,

"1.—For fixing the Number of Persons who may occupy a House, or Part of a House, which is Let in Lodgings, or occupied by Members of more than One Family.

"2.—For the Registration of Houses thus let or occupied in Lodgings.

"3.—For the Inspection of such Houses, and the keeping of the same in a cleanly and wholesome state.

"4.—For enforcing therein the provision of Privy Accommodation and other appliances and means of cleanliness, in proportion to the number of Lodgings and Occupiers, and the cleansing and ventilation of the Common Passages and Staircases.

"5.—For the cleansing and lime-whiting at stated times of such premises."

The Sanitary Law Amendment Act, 1874, Section 47,

enables Regulations made under the 35th Section of The Sanitary Act, 1866, to extend to

"Ventilation of rooms,

"Paving and drainage of premises,

"The separation of the sexes, and to

"Notices to be given, and precautions to be taken in case of any dangerously infectious or contagious disease, under the powers of this Act, or of the principal Act, or of the Acts therein mentioned."

The Nuisance Authority (*i.e.* the Vestries and District Boards) may provide for the enforcement of the Regulations by penalties.

There is considerable doubt in my mind as to the extent to which the Regulations should be enforced in providing and keeping the sanitary arrangements of the poor in an efficient state, as if frequent inspections are made, and the owners or rent-collectors are put to comparatively a large expense, the ordinary rent, which could with difficulty be paid, is increased, and if the additional rent be not paid the tenants are ejected, to carry a bad example elsewhere. In some instances in Hackney occupied by the residuum a whole street has been closed before the required repairs were done; the rents were raised, and the streets occupied by a better class of poor, when the destructive poor do not return to it. On the other hand, if due regard be not paid to the sanitary arrangements, including periodical cleansing, repair, &c., disease may arise in the streets and spread to the adjoining neighbourhood. Due care must therefore be taken by the inspector that whilst too much zeal is not displayed, yet nuisances injurious to health are not allowed to remain. The position of the landlord or middle-man is often by no means an enviable one, as it is most disheartening for him to find dust-bins broken, the water-supply apparatus damaged, the walls defaced, and his property injured almost immediately after it has been put into good order. If these houses are kept in a good sanitary condition no reasonable rent will pay the cost, so that either the inhabitants must remain for an uncertain

period in unsanitary houses, or the destructive poor must be taught by the force of circumstances that they must reform their habits, or else will be driven from house to house, as they cannot pay such a rent as will make them desirable tenants.

Having thus briefly noticed the various kinds of poor with whom we have to deal, and the general condition of their dwellings, I shall now discuss in detail some of their domestic sanitary arrangements, and especially the water-supply apparatus. I do not propose again mentioning their dwellings, or expressing any opinion on the buildings most suitable for them, especially as what is suited for some is not fit for others (for instance, costermongers with donkeys and barrows), as these subjects fall within the scope of Mr. Turner's Paper, but I desire to express my belief that the Peabody and other similar buildings are not suitable for what I call the poor. I prefer, when the cost of ground is not too high, four, five, or six roomed houses, with an outbuilding for use by the various inmates, as a scullery and washhouse. There are numerous houses of this kind in Hackney which are occupied by the poor, and are provided with fairly good sanitary arrangements. These are kept in pretty good order by an annual inspection, and the subsequent visits necessary to obtain the removal of any nuisances existing on the premises.

The most important of the sanitary arrangements of the poor is the water-supply and water-supply apparatus. In some London parishes the supply is almost entirely derived from what is termed the constant, such as that of the East London Waterworks Company; whilst in others only a comparatively small proportion is so given. A constant is much preferable to an intermittent supply, as by a trifling alteration of the pipes water can be drawn from the main instead of from a cistern. I am also informed by an engineer to a company that the waste of water is less on this plan, as the fittings differ to a certain extent from those used with an intermittent supply. In many poor houses there is not a cistern when the supply is on the constant.

This is objectionable, as when the water is shut off for the insertion of or repairs to the stop-cock on the supply-pipe of adjoining houses, or any alterations or repairs outside this stop-cock, the inhabitants of a whole street are sometimes left without water. Repairs to a pumping-engine also cause the same inconvenience. As many houses in the constant have not even yet a screw-down tap on the supply-pipe, a stoppage in the supply of water is perhaps more frequent than it will be hereafter when these are universally employed; but after much experience, partly as regards my own house, I strongly urge the necessity for a cistern in all cases. It is true that when the cistern supplies the water-closet with water, if the pipe and tap connected with it remain in the usual place over the sink, dirty, or otherwise contaminated water, may be used instead of that from the main, but with due care this ought not to occur. I find that the best way of obtaining a supply of good water is to have a length of pipe connected with the supply-pipe before it reaches the cistern, with a screw-down tap placed over the sink, so that water can then be drawn from the main instead of from the cistern. This arrangement has been extensively carried out in the Hackney district amongst the poor, although owners have in many instances made great opposition to it, and indeed in some instances have refused to carry out the suggestion. It is much to be regretted that the powers of the Vestries and District Boards of the Metropolis are not sufficient to enforce a proper water supply for drinking and domestic purposes, as well as for flushing closets. It is true that the cistern which is provided for flushing water-closets, is furnished with a pipe and tap for drawing off water for domestic purposes and for drinking; but this is not enough, there should be power to compel owners to disassociate the drinking water from that used for other purposes. When the water supply is on the constant this can be done as above-mentioned at a trifling expense, and when it is not on the constant by the intervention of a flushing-box between the cistern and the closet. This however is not, in my opinion, sufficient, as the cistern is often placed in or above the

closet, forming part of its roof, as so frequently obtains amongst a majority of the small houses in Hackney and elsewhere. The arrangement is also most objectionable, as the cistern cannot be readily cleaned out, is exposed to frost, and if there be not a water-closet service-box or flushing-cistern, the water may be contaminated by effluvia from the pan, which is often very dirty. Many persons will not believe that air passes into the cistern when the handle of the closet is raised, but I have seen this happen on many occasions, and met with two severe cases of diphtheria in a large house where none of the other sanitary arrangements were defective.

The flushing-box is often by no means of a satisfactory make or properly fixed, being usually of too thin a material, whilst from its shape it is likely to crack when the contained water freezes, and is also often fixed in so slight a manner as to be readily pulled down. I have often seen it placed so low, to avoid the cost of a couple of feet of down pipe, that children climbed on the seat and interfered with its working. The ball-tap often ceases to shut off the water in consequence of the arm connecting the ball with the tap becoming straightened from use, so that the poor will often put a stick under it to keep the ball up and shut off the water. I have under such circumstances known the pipe to be knocked together, and the closet kept without water for a lengthened period rather than inform the owner. A little grit getting on the leather or india-rubber in the old ball-tap and in the kind of draw-off tap commonly used at present, causes a leak, and consequent loss of water, which might be easily prevented by a more frequent inspection of the water apparatus by the company's officers. I also feel persuaded that if the water companies' officers would take out the defective leathers from the taps, and put in new ones, much waste of water would be prevented. I shall not suggest any make or pattern of flushing-box, as perhaps Mr. Turner will refer to these, but I think I am not going out of the way to mention that a flushing-box fitted with a syphon is a most efficient kind, as it admits of the whole

flush being delivered after children or others have used the closet, and have not kept the handle up for a sufficiently long time. This box, if fitted with a down-pipe having an internal diameter of an inch and a quarter, will give a sufficient flush provided at least two gallons are discharged at once. The down-pipe in the poorer class of houses is usually too small, and the handle is not held up long enough for the pan and drain to be sufficiently flushed. This is one of the causes of the drains in poor houses getting blocked up, but as a rule choked pans and drains occur either from neglect, or too often from stones, tins, sticks, and other things being put into the pan by children. To remove these obstructions it was by no means uncommon for the poker or a stout stick to be taken and the fancied obstruction rammed at until the trap was broken. This is one of the instances in which a little less energy and a little more knowledge would be useful.

There has been a great discussion, which I think has now nearly terminated, as to the relative merits of hand (pail) flushing and a supply of water from a proper apparatus. When poor persons did not generally understand the use of a water-closet (which, by-the-bye, seems but little known to immigrants from rural districts), there might have been some ground upon which those who recommend pail-flushing could stand, but now there seems to be no reason why every water-closet should not have a proper supply of water laid on. There is no doubt that as a rule the closets which have a water supply are rarely so filthy as those that are cleansed by hand-flushing ; and that the proportion of dirty pans is much larger amongst hand-flushed than closets provided with a proper apparatus.

When an intermittent is changed to a constant supply, the size of the ferule in the main, which is usually very small, should be increased so as to admit of a pailful of water being obtained from the draw-off tap as quickly as could be done under the old system from the cistern. This is a matter of considerable importance, as in many cases the owners request the water company's

officials to put in a smaller sized ferule than that provided by the bye-laws. This is quite regular provided the owner obtains the occupier's consent in writing, but is probably often done without that formality. The chief object of this is to lessen the strain on the fittings and diminish the cost of keeping the apparatus, especially the draw-taps, in proper order, so as to prevent the waste of water. Numerous complaints were made to me, when the constant service was introduced, of the "dribble" instead of a full stream of water that flowed from the draw-taps. On the other hand, weak pipes and taps will not stand the pressure attending the use of a full-sized ferule, and much waste consequently results. I find that an eighth-of-an-inch ferule, if the pressure at the waterworks be good, and the house be not on an elevated part of the district, affords as good a supply as is ordinarily required, except perhaps by washerwomen. Water-waste preventers, which discharge a pailful of water each time, are extensively used in the poorer courts of Whitechapel and some other parishes instead of cisterns. The plan answers well in most cases, and as the water is obtained direct from the main, there is no fear of contamination, but they are objectionable in consequence of the time occupied in filling the receiver after each discharge.

The direct connection so often found to exist between the sink-waste and the house-drain is often injurious, as when the cover of the bell-trap is left off or broken a current of sewer-gas can, and often does, pass into the room. As the room is often used for living in, as well as for cooking and washing, the entrance of sewer-gas, often in a full stream, causes much disease. This sometimes consists only of headache, loss of appetite, malaise, and a disinclination for work, but neuralgia and other ailments frequently occur which interfere very much with the usefulness and enjoyment of life. Indeed I scarcely know of a greater source of discomfort than such sink-wastes. A bell-trap in the sink and other places is often worse than useless, as the cover is usually left off; and even when on they afford no protection, except

when full of water, so that in yards and other places where they depend for the small efficiency they possess on an uncertain supply of water from rain or occasional sluicing-down of the yard, they deceive those who trust in them. In Hackney I recommend that a grating of some kind or other be fixed over the opening to the waste in the sink, and that the pipe be carried through the wall into a yard-gully having an opening in it for that purpose. If the room should be so far underground that the pipe cannot be carried through the wall, it is connected with a P.- or S.-trap. This is not satisfactory, but cannot always be helped. When there is a bell-trap in the sink, and it is left off, and the attention of the occupier of the house is consequently called to it, the inspector is usually considered to be more nice than useful. The heads of the rain-water pipes are, especially in poor houses, often placed near windows, so that sewer-gas can make its way into the bed and living rooms without being suspected. In very many instances cases of severe sore throat have occurred time after time in the same room until this defect has been remedied, when it has ceased to recur. This remark applies with as much force to high-class houses as to those of the poor. Diphtheria, often fatal, also occurs apparently from the same cause, and I have met with typhoid fever in rooms where the pipes were similarly situated. I am in the habit of having rain-water pipes so placed cut off from the drains, and made to discharge the rain-water over or into a yard-gully. The latter is the best arrangement, as the top or grating of the yard-gully in dry weather is apt to become blocked up with drift of various kinds or the holes filled up by children. The latter occurs so frequently, that a few words from district visitors and others to occupiers of poor houses would often be useful.

The paving and drainage of the yard in poor houses are often bad, to a great extent, however, owing to the carelessness of the inhabitants, who often chop blocks of wood on brick or concrete paving, or even on the hearth-

stones. The difficulty in many houses of the poor in Hackney is to define absolutely what is the yard, as small houses were often built with gardens behind them, and the owners will not pave any portion of the small garden, and magistrates also object to make an order for them to do so. If all that may be called yard is covered with York or Victoria stone, or even with good concrete and bricks, the cost is comparatively so large that rents are raised, but if they remain unpaved, they are a source of great discomfort to children, and a cause of dirt in the house. Even when hard bricks have been laid down, the house refuse or garden mould is often thrown on the paving to so great a thickness that it is necessary to scrape the surface before its structure can be seen. It is true that this only occurs amongst dirty people, or in tenement houses where anything that has to be done for the common good is neglected. Regulations made under the Sanitary Act will assist inspectors in their efforts to have yards, water-closets and other places kept clean, but if the person letting the house in tenements will have to do this and other work for the benefit of his tenants, he will increase the rent to pay himself for the time so expended. In carrying out these regulations difficulties have often arisen regarding the amount of work to be done by the owner or middleman, because whilst every thing necessary for the preservation of health must be done, yet more than that should not be asked for, as the tenant is usually made to pay for every improvement. The cost of keeping houses in a cleanly state as regards the walls and ceilings is sometimes undertaken by the occupier of the rooms or the tenant holding from the owner, who is allowed a slight reduction in the rent; it is amongst these that the greatest difficulty exists i . obtaining repairs or even whitewashing. I may say that Regulations have been in force in Hackney and carried out since 1866.

The drains of the houses occupied by the poor, especially when the houses are old, are very often structurally defective, being often made of bricks with open joints from

which sewer gas and rats can escape. It is also a very common plan for several houses to be drained through an outlet common to many houses, to save expense and carrying the drain under houses. In practice I find this very objectionable, as the stoppage of the outlet causes great discomfort, and often injury to health, before the obstruction is removed or the outlet reconstructed, and I cannot see what injury to health can accrue if the drains under the houses are of pipes, and laid in concrete. As to brick drains under or near houses, I hold a strong opinion as to the necessity of their reconstruction with pipes, and being surrounded with concrete, even although they may then be in a sound condition.

The arrangements for the drying and washing of clothes are much better in the comparatively new houses than in the old, as a small washhouse and scullery common to all the tenants for this purpose is usually attached to the house. When there are several families in a house the occupants of a certain room or rooms have the right to use it on a particular day in order that the tenants may not clash with one another, so that the objectionable plan of washing and drying clothes in the living and perhaps sleeping room much more rarely obtains now than formerly. I cannot say much about this in more than two or three parishes, but many years ago, when practising at the East End of London, I have frequently attended sick persons in a room where wet clothes were hanging up to dry. This is most objectionable, not only on sanitary grounds, but because in such cases when the husband comes home to a meal he may find the room little better than a laundry. It is of course more objectionable in a sleeping-room, as the beds and bedclothes are rendered damp by the watery vapour given off in drying, especially as the poor have a great objection to opening their windows for ventilation. The free admission of pure air into their rooms ordinarily forms no part of the domestic arrangements of the poor.

The dust-bins are very often—indeed usually—a source of

some discomfort, and I believe sometimes of disease. The poor rarely burn their vegetable refuse, or the shells of crabs and other shell-fish they consume, partly owing to the fires and fireplaces being too small to burn the refuse without creating an offensive smell. Most of the fireplaces are open, very few kitcheners being used, so that if the vegetable and other refuse be not removed every week it becomes offensive, and undoubtedly in summer predisposes to diarrhœa amongst the children who play in the small gardens or back yards. The covers to the dust-bins, if of wood, are, amongst the residuum, very frequently chopped up and burnt, and the bins themselves are ruined, apparently in many cases out of wanton mischief. The best kind of dust-bin with which I am acquainted is made of iron, $\frac{1}{16}$th of an inch thick, well rivetted together, with strong hinges to the lid, and without a bottom, so that the bin can be lifted off, and the dust, &c., be easily removed. These bins, which will hold about a fortnight's dust, &c., for a small house, are neither easily destroyed nor injured, and are by no means costly. Of course larger ones can be procured. The arrangements for the removal of dust and house refuse are generally by no means good, as the system of asking for gratuities is very common, and acts as a check on its frequent collection amongst the poor. Besides this, in many metropolitan parishes, the contracts are entered into for their removal at a lump sum, so that it is in the interest of the contractor—especially at present, when dust is not saleable—to remove it as rarely as possible. Several of the metropolitan parishes have their own wharves and plant, and employ their own men not only in removing the refuse, but in making it useful for farmers or for sale as breeze. Others, again, hire the necessary plant, &c., whilst one or two, including Hackney, pay for the work being done under the personal supervision of their own officers at a certain price per load, the matters collected being taken to a wharf or shoot outside or on the confines of the parish. In this way, as a ticket is given for each load collected, payment is only

made for work done. I am quite aware that the removal of dust does not form part of the domestic sanitary arrangements of the poor, but I thought I should be excused for this very short divergence from the limits of my Paper. I have not referred to the underletting of rooms, and consequent overcrowding; indecent overcrowding; appliances for sleeping in, that is to say, beds, bedding, &c., and many other subjects which might have been discussed, because the time at my disposal would not allow of more than a mere mention of these matters.

THE IMPROVEMENT OF THE SANITARY ARRANGEMENTS OF METROPOLITAN HOUSES.

By Ernest Turner, F.R.I.B.A.

Even had Rome been built in a day, twenty minutes would have been a small proportion of that time to allot to its sanitary arrangements.

London is a little bigger than Rome, and its sanitary, or perhaps I should rather say insanitary arrangements, somewhat more complicated. I do not profess to set them right, or even to suggest to you in any detail an altogether exhaustive scheme for setting them right in the course of the twenty minutes allotted to the present Paper. The utmost I can attempt to do is to offer a suggestion or two here and there on fundamental points, selecting, even among these, such chiefly as would appear hitherto to have received a smaller share than others of public attention.

One important branch of my subject I need scarcely touch, the able and interesting Paper by Dr. Tripe having efficiently disposed of the sanitary question as bearing on the houses occupied by the poor. I would only in passing add a word of endorsement from my own experience, to that gentleman's admirable remarks on the water question.

Some seven years since I was employed by a leading sanitary journal to institute a thorough survey of the milk shops of the metropolis, and I trust I shall not be suspected of any *arrière pensée* in saying that the water supply formed necessarily an important feature of the inquiry. Its results were too extensive to be even glanced at here. It may be found by anyone interested in such matters, in the *Sanitary Record* of 1877. I will only say now that they thoroughly bear out Dr. Tripe's observations.

I am afraid that in dealing with this subject of house-room for the poor, we do not always formulate with sufficient accuracy our notions of the class for whom we are catering. The London poor do not occupy houses or suites, with bedrooms, sitting-rooms, kitchen, nursery, and so forth. They could not afford to pay for them in the first place, and would not if they could in the second. Hence the work which has so far been done in this direction, excellent as it is, has not really had much practical bearing on that particular problem. The artisan has had his accommodation immensely improved, but the artisan is not, unless by grace of the gin bottle he takes pains to render himself so, what can properly be termed poor. There are, indeed, some who even go so far as to think that he has been a little too well looked after, and has in fact come in, on somewhat false pretences, for an undue proportion of the help intended for his less fortunately placed brethren. The real problem before us is the sanitary housing, not of the artisan, but of the labourer. And if we mean to solve it, we must face its conditions as they come before us, not invent them for ourselves. And the first and plainest and most inexorable of these conditions is just the one condition that many have hitherto devoutly refused to accept. The labourer has to live in one room, and it is no good endeavouring to persuade either him or ourselves that he can or will occupy more. From 3s. 6d. to 4s. a week is all that he can pay, and more than he can afford. And for 3s. 6d. or 4s. a week, more

than one room is not to be had. Not to be had, that is to say, on the principle so dear to the British mind, even when most gallantly indifferent to every other consideration of decency or self-respect, that of the castellar character of the Englishman's domicile. Whether there might be haply a possibility of so far modifying this Britannic boast as to admit of the introduction of common kitchens, and dormitories either undivided or divided into cubicles, is a question well worthy of the consideration of the new Royal Commission, Certainly what are known as common lodging-houses are, in these days of systematic inspection, by far the most sanitary of any dwellings of the poor. It may be a question, too, how far this serious prejudice, which undoubtedly exists in the minds of the poor against the huge new blocks of model buildings, and which of course arises out of the castellar theory, may not sooner or later wear out, as the kindred prejudice against what are known as "flats" has already pretty nearly worn out among the wealthy classes. Perhaps, were model lodging-houses constructed to look a shade less like model prisons, and an occasional grass plot, a scrub or two of lilac or laburnum, or possibly, in some festive situation, even a gratefully-patulous plane-tree substituted for the present somewhat severe virtue of the stone-flagged courtyard, this desirable consummation might be a little hastened. But, be that as it may, there can be no question as to the pure and unadulterated idiocy of the plan upon which the British labourer's lath and plaster castle is at present arranged. Anybody who builds a house or a street of houses for his occupation, knows perfectly well that every house in it will be occupied, and is practically intended by himself to be occupied by pretty nearly as many different families as it contains rooms. Yet to no one does it ever occur to construct his houses on any other plan than such as he would adopt, were each house to be exclusively occupied by a single family, with the dining-room and the master's study on the ground floor, a couple of drawing-rooms on the first, and a quantum in-suff. of bedrooms above. The

utmost concession he will make to circumstances is to omit the folding-doors between the drawing-rooms, and give a choice of nurseries by introducing kitchen boilers into unexpected bedrooms. But when he has achieved this much, his adaptivity is exhausted, and the scarcely-completed house at once assumes that air of having "seen better days," like the antique furniture of Wardour Street, with the worm-holes carefully bradawled before the stain and varnish are put on. At least, one would think, these eccentric tenements might be built double-fronted, so that one passage and staircase might serve for two. In a street of a hundred houses there would in this manner be effected a trifling saving of say, 200 feet of frontage. That is to say, a space sufficient to build about a dozen houses more, or rather not to build them, for no more bricks, mortar, or labour would be required than at present. But simply to have a dozen more rents per week coming in.

I shall, perhaps, be told that this would be no advantage to the labourer-tenant, but only to the landlord, who already gets quite enough out of him, and with whom I confess my sympathies are not sufficiently strong to induce me to make him a present of the suggestion.

But this would be a mistaken view. The great difficulty for the poor man is cost. The great factor in cost is shortness of space. The man who can make five houses grow where four grew before, confers as great a boon on the houseless as he who works a similar increase with ears of corn upon the hungry.

Another excellent economy is that of putting the wash-house on the top, which both saves space and conduces to dryness, ventilation, and other sanitary desiderata.

But half my time is already gone, and I must condense.

Upon the great question of sanitary fittings, therefore, I will not attempt to touch, further, than by strongly endorsing Dr. Tripe's views as to the supreme advantage of absolute simplicity. I will only further, in this connection, ask your attention to these plans, of a really

admirable block of buildings recently erected at Westminster, by a most uncharacteristic member of that class too generally known as the common enemy of mankind the "speculative builder." These blocks are admirably planned, substantially built, and thoroughly "sanitated" throughout. The partitions are solid, the skirtings of cement, the floors and staircases fire-proof, the waste pipes disconnected from the drains, the soil-pipes outside the building and thoroughly ventilated, the drains properly laid, with access and disconnecting chambers; and they are paying *more* than 7 per cent.!

An important improvement is now being introduced in the partitions between rooms. These, as unless you are speculative builders yourselves, you probably don't know, usually consist of two flimsy screens of lathwork, daubed over with a thin film of mud, euphemistically termed plaster, and with a space between, admirably calculated to fulfil various purposes, the principal among which may be considered the accumulation of dirt, the housing of vermin, the conducting on occasion of fire from floor to floor, and so forth. Further, being six inches thick, they of course deduct that space from the area of the room. Under the new plan you will find in their stead two solid inches of a mixture of plaster and iron, formed like the feet of Nebuchadnezzar's image. This ingenious combination is not intended to support the weight of the building, and need not therefore lead to fear of any such catastrophe as that which befel the Babylonian giant. But I must own to some slight doubt as to the result in case of fire. It does seem to me possible that the expansion of the iron might lead to a solution of continuity on the part of the plaster. This, however, may easily be ascertained by experiment, and indeed, has been so already to a limited extent. And à propos of fire, let me draw your attention to the fact that cement, however patiently it may stand the action of fire, entirely loses its equanimity when the engines take up their parable and begin to play upon it; and as your engine is rather an irrepressible personage on these occa-

sions, this somewhat interferes with the beneficial effects of cement.

Now of all the odd things that you would think of applying for the purpose of developing fire-proof qualities, perhaps the oddest would be sulphur. But it is a chemical, scientific and practical fact, that Portland cement when mixed with a certain proportion of sulphur, will stand both fire and water to any reasonable extent without perceptible change.

So much, then, for fire-proofing; which, I may add, possesses an advantage even greater than that of security from conflagration. There is no such disinfectant as fire. And though it may not be worth while to burn your house down to roast a pig, it is amply so to burn out a room—of course after removing your furniture—to expel the small-pox from the walls. The upholstery may be treated in less drastic fashion. Dr. Richardson, in a paper I heard him read on Hospitals for Infectious Diseases, suggested the use of iron buildings, so that the walls might be exposed to the purifying action of fire, but, for many reasons, iron alone does not lend itself conveniently to this purpose. How far cement and sulphur might be used on the surface of walls of hospital wards, and how far the combination of iron and this material may be advantageously employed, are questions worthy of serious consideration and investigation.

Another excellent plan for obviating the danger of fire arising from the use of laths is that patented by Mr. Hitchins, and consisting of plaster screwed up in slabs and faced with a setting coat. The whole front of the sanitary and insanitary houses, shown at the present Exhibition, is constructed in this way.

I need hardly tell you, that this branch of my subject is very far from having been exhausted in these few and hurried remarks. But my friend, Mr. Rogers Field, has unfortunately been disabled by sickness from preparing a paper we all hoped to hear him read; and I have, at his suggestion, been asked to touch briefly upon the

defects common to almost all London houses, and upon the improvements which may be effected in their sanitary arrangements, short of the drastic treatment of pulling down and re-building.

For the former, my time will be pretty well exhausted in reading you a mere dry catalogue:—Leaky drains; defective junctions; drains laid without sufficient fall; soil pipes with slip joints, placed inside the house, unventilated and formed of different materials; old brick drains forming connection between house drain and sewer; that terrible enemy to a healthy house—the pan closet with its attendant evil, the D trap; waste pipes of baths, safes, lavatories and sinks connected with the drains; cisterns in inaccessible positions, where they cannot be cleaned, having their overflow or waste pipes connected with the drain; bell traps to sinks and bell traps in floors, the former generally off, the letter generally dry, in either case admitting air direct from the sewer.

These, and many more, may with some certainty be reckoned upon in any house not built within the last twenty years. And, I am afraid, in an uncomfortable proportion of those of later date. The most important of them will be found practically illustrated in the model Insanitary House in the present Exhibition, whilst alongside of them the model Sanitary House will show what the corresponding arrangements ought to be. Those among you who are not practical architects or engineers, will probably be a little surprised at the very slight difference between the two which will present itself to the eye. To that more important organ, the nose, I need hardly say, they will in the present case present no difference whatever. It has not been thought advisable to carry realism to the extent of turning on actual sewer gas, or incubating practical typhoid. But do not let surprise degenerate into contempt.

When poor King Richard spoke of that little pin with which Death "Bores through the castle wall—and farewell, King!"—the wall to which he was referring needs only to have been the wall of a badly-constructed sewer, to make his poetic phrase no metaphor, but a grim reality.

With that reality we have more or less to deal whenever we take possession of an old house. But we are apt to embarrass ourselves unnecessarily in the dealing with it, by jumping too hastily to the conclusion that there is nothing to be done, and that if once you begin to meddle with an old house, you will end in bringing it about your ears altogether. This is pure delusion. An old house is often, too often, better built and better able to stand a little pulling about than a new one. And one thing, at all events, you can always do; you can always disconnect the drains. By which, it may be as well to explain for the benefit of my non-technical hearers, I do not mean cutting off the drainage. "Disconnecting the drains" means simply interposing between the house and the sewer, a water trap, and on the house side of this trap placing either a short length of open channel, or at least some convenient opening to the air through which fresh air continually flows along the whole length of the drain and up the soil pipe, which should be carried up full-bore well above the roof and left open at the top. This you can do at all events. And in doing it you will cut off the chief danger to health, and at the cost of a very few pounds. If in the course of the operation you find that the house drain itself is constructed of ill-joined pipes or rotten bricks, you will most probably be able, though at a somewhat larger cost, to replace it with properly laid and properly jointed pipes. All waste pipes can be arranged to discharge in the open air. The old-fashioned and poisonous fittings can be exchanged for modern appliances; soil-pipes can be ventilated by carrying them up above the roof, and cisterns removed to an accessible position, properly covered, systematically cleaned, and cut off once for all from communication with drains and so forth. And don't be content with doing this to what you are told is the cistern for drinking purposes. The cistern for drinking purposes is, and always will be, the cistern from which it is at the moment most convenient for your servant to fill your water-bottle. The open gutter, too, which an exploring ex-

pedition into the cobwebby region above the trap-door on your top-landing would probably discover right across the inside of the roof, may be readily removed to a more fitting position. And other domestic arrangements, equally misplaced, under staircases and in dark unventilated corners, may, with a little contrivance and a little skill be transplanted to more wholesome situations, or at least supplied with some means of ventilating themselves, otherwise than into the house. Even the æsthetic side of the question need not be altogether neglected. And æsthetics are wholesome when kept in their proper sphere, and within their proper limits. Perhaps the old lady who refused to stay in the Workhouse infirmary because there was no proper dado may be thought to have carried her views in this direction a little too far. And I don't know that I myself could very strongly urge the guardians to increase the rate with a view to supplying the deficiency. But depend upon it, the body is none the less healthful for the mind's being pleasantly occupied. And amongst the many improvements of which a good old brown brick domicile of the Georgian era is susceptible, may be most decidedly reckoned that of its personal appearance.

DISCUSSION.

Mr. ROGERS FIELD said the observations of Dr. Tripe with regard to water struck him as being particularly valuable and worth studying. It might appear at first sight that the subject consisted of a number of details which were not of much importance, but a careful study of those details would show that this was not so. Two of the subjects which Dr. Tripe had referred to were specially important. First as to the position of the cistern, which, it was stated, was often placed in or above the closet. This arrangement might have a serious effect upon the health of the inhabitants. If the cistern was put in a place where it could not be seen, and in a place where there must be bad smells, it was certain that the water would become

more or less contaminated and that the cistern would not be looked to from one year's end to another. With a little consideration it was always possible in building new houses to place the cistern in such a place that it could be looked after. One way in which this could be done was shown in the model sanitary house in the Exhibition. In old houses, where it was impossible to shift the cistern, a great deal might be done by giving extra light. He knew of cases where children had been seriously ill, the cause of which could not be discovered for some time, but afterwards the cause was traced to, in one case, a mouse in the cistern, and in the other a dead bird. Another detail to which he might refer was that special arrangements should be made for flushing water-closets. One point mentioned by Dr. Tripe was of the utmost possible importance, namely, that you should have some arrangements by which one touch discharged sufficient water to flush the closet, as a great many people would not take the trouble to hold the handle down long enough for this purpose. With regard to Mr. Turner's paper, he could thoroughly endorse what had been stated with reference to the defects discovered in the ordinary house. Mr. Turner stated that the defects existed in houses not built within the last twenty years, but he should rather say that the defects applied to houses built within the last ten years, and even to houses which were now in course of construction. This was a serious and important question. With reference to defects that existed in houses already built, it must be of necessity a very difficult problem how they were to be set right, and a very long and tedious process before they were set right. No doubt great improvements were taking place in that way, but it would be a long time before they could possibly hope that all the existing defects of sanitary arrangements could be set right. Surely with reference to houses that were being built, with the knowledge they now possessed, there ought not to be any difficulty in preventing the errors which had been pointed out. The importance of this would be seen when they recollected what was going on in London.

At the present moment there were between 6000 and 7000 houses being built every year in London, being an average of twenty per day; and if these buildings were not being fitted with proper sanitary appliances, or contained any of the defects which had been mentioned by Mr. Turner, what an enormous difference it would make in the future. As London was not under the Public Health Act of 1875, the byelaws drawn up under that Act did not apply, and the consequence was that the metropolis had no series of byelaws regulating the sanitary arrangement of houses. He was perfectly aware that a great deal had been done by boards and vestries, though he thought this was due in a great measure to the action taken by the medical officers of health, rather than by the engineers, but notwithstanding that, the fact remained that defects in construction and drainage were very generally allowed. London was divided into thirty-nine sanitary districts, and these districts had not any regulations, or if they had, they did not enforce them. Though it was very difficult to generalise, he might safely say that at least half the houses now being erected contained the defects which had been pointed out by Mr. Turner, and that matter ought at once to be taken into consideration. The cost of having the houses properly sanitated was comparatively nothing in the first place, though if the defects had to be remedied afterwards, the expense was considerable. He thought what was wanted was a set of byelaws similar to the Model Byelaws issued by the Local Government Board, which were now being adopted all over the country. His own experience with reference to the byelaws which did exist in the metropolis was, that they were hardly ever enforced, and almost the only time that he had been interfered with by the sanitary authorities, was to prevent him doing what was right. On one occasion when he wished to construct a disconnecting manhole in a mews outside the house to cut off the air connection with the public sewer, he was prevented from doing so by the Sanitary Authorities.

Prof. CORFIELD wished to express his feeling of gratitude to the readers of the two papers for the very interesting and instructive addresses which they had given, and to bear them out in several points which they had mentioned. In the first place he should like to say that he agreed with Dr. Tripe—and he gathered from Mr. Turner's paper that he agreed with him too—that the question with regard to the poor was not a question of artizans' dwellings, but the dwellings of a lower class than the artizans. The artizans were perfectly able to take care of themselves, and they needed no exceptional regulations for them. With regard to the dwellings of the class still poorer than the artizans, there was one exceedingly important thing, and that was the question of the removal of dust. He considered that one of the most important things in connection with the dwellings of the poor, because if the refuse which was called dust—which included organic matter capable of decomposition and putrefaction, engendering foul smells, making the air about the house unhealthy—was allowed to accumulate in the house, it was perfectly impossible for the inhabitants to be healthy or to be clean. This habit necessarily made the inhabitants careless about other habits of cleanliness, and so one important point in their moral education was neglected. The solution of the dust question in London was as simple as A B C. The majority of the public authorities in London removed the dust—or rather did not remove it—upon the system which was adopted when dust was a valuable commodity. At one time the contractors competed, in order to pay the local authorities large sums a year for the privilege of removing the dust, and they took very great care that they got the dust, having paid so much for it, for sometimes they actually went so far as to prosecute, and to prosecute successfully, people who used the dust for manure in their gardens. Under that condition of things, the plan of letting out the dusting of towns to contractors was a very good plan, because it was to the advantage of the contractor to get all the dust he paid for, and he took care

that he did. But now the state of things was altered, for dust had no value in itself, and it cost a great deal to get rid of it. The parishes had now to pay the contractors considerable sums every year for collecting it and taking it away, and it was obviously therefore to the advantage of the contractor to take away as little as he could. In the class of dwelling-houses of which he was speaking, where the inhabitants could not fee the dustmen, the dust was not removed. He was himself a medical officer of health in London, and as such he very much doubted whether he could get his dust removed without feeing the dustmen. As the difficulty was known, the solution was perfectly clear. Since the dust was no longer valuable, it was the duty of the sanitary authorities to collect it, and get rid of it, and that was the only way in which it could be properly done.

Mr. LIGGINS observed that some parishes already did that.

Prof. CORFIELD said he was quite aware of that; but others did not. He quite agreed with Dr. Tripe that what was called combined drainage of houses was a great mistake, for if one drain was blocked up it blocked the drainage of a whole set of houses. He mentioned this more particularly, because the practice had been in one particular form made, not exactly illegal, but so disadvantageous that it came to the same thing as being illegal, for it had lately been decided by the Court of Chancery that where the drainage of other houses passed under one particular house, the lease of such a house was not valid unless it was mentioned in the lease that there was an easement for soil as well as water. Of all the defects mentioned in connection with houses both great and small, the most serious defect in his opinion was the connection of the waste pipe of the cistern containing drinking water with the drain, for the air from the sewer came up into the cistern, and as the cistern was in the majority of instances covered, the air came up in a vitiated condition into the cistern, the suspended matters fell into the cistern,

the water was drunk, and frequently led to enteric fever. Some years ago he took the trouble to investigate this matter, and he then found that the vast majority of cases of enteric fever occurred in houses where that was the main sanitary defect. All the sanitary defects were small as compared with this one, for the air which came from the sewer into the cistern was not diluted at all, and as the water became poisoned, the people who drunk it did so with the most pernicious results. With regard to the siphon action water-waste preventers which had been referred to, he thought that they were great improvements upon previous arrangements, and that their use should be encouraged. Some of these preventers got out of order, and a certain number were fixed out of order, and then they gave a worse flush than was commonly obtained in the ordinary way, and hence it was very important that they should see that the arrangements were in order, and for this purpose they should be inspected from time to time. As to the connection between rain-water pipes and the drain, he found that in houses where the rain-water pipes were near windows and went down into the drain, whether there was a trap at the bottom or not, if they were not disconnected from the drain, illness frequently occurred. There were many other important points in connection with the papers, but he would not trouble the meeting with any further remarks, except to express his entire concurrence with the plans for the disconnection of house drainage from the sewer. It was necessary to do this, though he did not agree with what Mr. Field had said, that opinion was quite unanimous upon the subject, for he knew that some persons whose opinions were entitled to weight, were opposed to the system of disconnection referred to.

Dr. ALFRED CARPENTER thought there was one matter which would probably strike all those who had heard the admirable papers which had been read, and also the observations which had fallen from the preceding speakers, and that was that they might call spirits from the vasty

deep; but would they come if they were called? They had byelaws and certain sanitary arrangements which were said to be absolutely necessary, and yet they were told that at the present moment a large number of houses were being built, the sanitary arrangements of which were not being carried out properly, and then, when they met with half a dozen people interested in sanitary work, they would find a disagreement as to what was proper and what was not. As every one was aware, there were sanitarians and sanitarians. Amongst those who had paid a life's attention to this subject, there was not that difference of opinion. Although on the very point just spoken to by Professor Corfield there might be a difference of opinion, it was of a very modified form as compared with the important subjects which ought to be carried out everywhere, and about which there was no difference of opinion amongst true sanitarians. It was only the other day that he heard several architects express an opinion that it was not advantageous for an architect to be known as being very well acquainted with sanitary work, and if that was so, it was evident that something more was wanted than simply byelaws. What was wanted was a class of persons who should do what the readers of the papers had demanded as necessary, namely, to inspect continuously, so as to see that those byelaws were in operation, and that they were not put out of order by architects and those who did not understand the first principles of sanitary work. There was no doubt about it whatever that in districts where houses were built, where every kind of arrangement that was required for the purpose of making those houses healthy were properly carried out under the inspection of the local authority, before the houses had been occupied twelve months half a dozen of the arrangements would have been altered and the houses became insanitary. To meet that difficulty, it was necessary that there should be a fixed and regular inspection by persons who knew perfectly well what was wanted, and these inspectors should be totally independent of the owners and

occupiers. These inspectors should be appointed by the local authority. With regard to some of the points that were mentioned by the readers of the papers, he might refer to the question of house refuse, which had been referred to already by Professor Corfield. The removal of dust from the houses of the poor became an absolute necessity, if the houses were to be kept clean. This work must be done by the local authorities, and it ought not to be a question of pounds, shillings and pence. There was another thing which ought to be looked into in connection with that, and that was the way in which to diminish the amount of dust. It was very important in the interest of that great metropolis, where the expense of removing from its centre a load of dust became enormous, costing from 10s. to 12s. a load, that the amount of dust should be diminished; and therefore, in carrying out any arrangements for the purpose of making healthy homes for the people, they must keep that point in mind with regard to the construction of fire-places where a certain amount of dust was made. It was important that as far as cooking was concerned, that if if there could be certain arrangements by which the people could be warmed without a fire-place being required at all, it would be far better for their health than having that class of fire-place which was commonly found in the homes of the poor. It was true that fire-places promoted ventilation, but the authorities should take care that proper ventilation was provided independently of the fireplace. As far as cooking was concerned, if they could instil into the minds of the lower classes a knowledge of the cheapness and excellence with which cooking could be carried on by gas it would be greatly advantageous to the welfare of the people themselves. There could not be a shadow of doubt but that it would be far cheaper to have food cooked by gas, and if the houses were warmed in a similar manner they would get rid of the introduction of an immense quantity of coal, which was now brought into London for the purpose of cooking, and which helped to make the houses filthy and to deteriorate the

value of London as a residence by poisoning the atmosphere. If they could get rid of the 800,000 fires used in London for cooking they would be helping very much to benefit the pecuniary side of the question as far as the poor were concerned, whilst they would be helping very materially to purify the atmosphere in which they lived. With regard to water-waste preventive cisterns, he was certain from what he had observed that the twopenny-halfpenny water-waste preventers in use in houses of the poorer class had a tendency to disgust people with their use and really did more harm than good, and he should strongly advise those who intended to put up water-waste preventive cisterns to go to the Parkes Museum and study the specimens there exhibited before they allowed their plumber to put in a bad one. The way in which sanitary work was mismanaged, owing to the ignorance of what sanitary work ought to be, was so manifest to those engaged in the work, that he could not help but feel pleased at these Conferences being held, because it would give an opportunity for disseminating some sound points connected with sanitary work, and enable the public to judge for themselves as to what was best to be done. He would advise every one who was interested in the work to visit the Parkes Museum, where they would be able to judge of what the arrangements should be with regard to water-waste preventive cisterns and traps, and everything connected with sanitation. Upon the subject of drying clothes he thought it was a very serious evil to poor people that they should be called upon to live in the same rooms in which clothes were being dried, for it was evident that whilst that arrangement was being carried on the use of clean clothes became the exception and not the rule. Some kind of arrangement should be made in all the proposals for building houses for the poor, by which there should be drying closets, or some general place where clothes could be dried, as the unhealthiness of the practice of drying clothes in the room must be manifest to any-one who went into a washhouse while washing was going

on. He hoped that those who were paying attention to this subject would take care to consider the point, and to endeavour to meet the difficulty that necessarily belonged to it.

Dr. BARTLETT was very pleased to find that the discussion had become a dusty one, for he could speak very feelingly on the subject, inasmuch as although he lived within a hundred yards of Grosvenor Square he had had great difficulty during the last year in getting rid of the refuse. They had been willing to pay handsomely to get rid of the contents of the dust-bin, and the reason he spoke feelingly was because in his own immediate neighbourhood there had been disease in the dust-bin; the accumulation had led to the exhalation of noxious gases, owing to which a near neighbour had been confined to a bed of sickness, and he himself had had to apply several times to the Vestry of St. George's before he could get his dust removed. If that was true of the West End of the metropolis, what must be the difficulty of removing the refuse of what Dr. Tripe had called the residuum? The difficulty would be enhanced by the mere fact that these people could not afford to fee the dustman and their dust-bins would be full of refuse, and not only would there be disease in the dust-bin, but there would be death. This was the experience of those who had studied the matter, and he was grateful to those gentlemen who had given prominence to the matter. Still this was not the subject upon which he came to speak; he came prepared to speak upon a subject which had been commented on already by Mr. Field, Professor Corfield, and Dr. Carpenter, and consequently much of what he had to say had already been dealt with.

There were two points in Mr. Turner's valuable paper which struck him with very considerable force, namely, the economy of lodging those who were not of the artizan class but the residuum, and making those lodgings so far comfortable and suitable for the purpose that you could induce the class whom you intended to benefit to take

advantage of them. Unless you had economy in the building of the houses the rental would be inevitably beyond the means of those who had to occupy them, and the first thing was to be able to erect the buildings commodiously, and handsomely as far as might be done with the means, and then to insure that the tenants would be able to pay their rents with regularity, and to do that the rents must be small. It was scarcely possible for a man with small means to obtain a room for less than 3*s.* 6*d.* or 4*s.* a-week. His own experience enabled him to state that houses could be built so as to let single rooms for less than that, and to give part of the laundry and other comforts as well. Suppose this to be true, as had been stated over and over again by those who had studied the subject, large buildings might be built in such a way as neither to offend the eye nor the self-respect of the poor, and they could be let at from 2*s.* to 2*s.* 6*d.* a room. A very important element had cropped up while Mr. Turner was reading his paper, and that was, if these large artizan dwelling-places were erected there would be fearful scenes in the event of a conflagration occurring. When great economy of space was effected the number of exits would not be sufficient, and there would be very considerable danger of the fire being communicated from one floor to another, and from one part of the building to another. Just imagine the fearful loss of life which would ensue, not from the actual burning of the building, but from the panic, when down the narrow staircases the people came, not in dozens, but perhaps in hundreds, all trying to save some poor articles of furniture. If they were to reassure the minds of those who were to occupy such dwellings as those, it would be necessary to show the people that they were fireproof; and some complete experiments should be made, in order to show that better means could be used for rendering the walls fireproof. The other day Mr. Turner spoke to him about the use of a mixture of cement and sulphur, and being very much struck with the idea, he went home and experimented upon the mix-

ture by subjecting it to the heat of a furnace, and afterwards drenching it with water. The effect was very surprising; the cement made up without the sulphur was broken up, and the lime became desiccated and crumbled to dust when water was put upon it, but the cement made with sulphur stood the test admirably well.

Mr. E. COOKWORTHY ROBINS observed that Dr. Carpenter had said there were sanitarians and sanitarians. He might have said there were architects and architects, for some took greater interest than others in particular matters appertaining to their profession. He could not say that the public appreciated altogether those architects who took up sanitation, as they were apt to think that their minds were not filled sufficiently with the artistic part of their profession, and therefore they took up with the practical parts of it. Such a suggestion as that had come to his ear; but it was a satisfactory thing to him to know, as an examiner at the Royal Institute of British Architects, that the two men who had passed best in sanitary matters came out of Mr. Waterhouse's office. There were those who were specially interested in this question among them, and they must not be spoken of as a class who took no interest in it. Architects looked to medical men to give them the principles which should underlie their work, and with the information so obtained they hoped to render great assistance to sanitary matters. The drawing on the wall was a very important one; what were called manholes had been spoken of as being necessary to place between the house and the sewer, but these manholes might be of any size and depth, and must be put in every position where you wanted to get a means of cleansing the drains. At every angle there ought to be a means of getting to the drains without taking up the floor, and none of the manholes, if properly arranged, need be in the house. Another point was this, that it was not only soil drains which caused injury to health, for an unpleasant smell was caused by bath water and the like, all of which ought to be thrown into a separate manhole before

entering into the soil-pipe. It was not many years since the house drainage about which they were speaking was introduced, and the system of public sewerage was really a system of laying on bad air to all the houses. It was not so long ago that cesspools were in use, but seeing that they were now bound to connect with the sewer, the necessity had arisen for disconnecting themselves from the evils which grew from the use of the sewer, and therefore they must now reconsider the basis of operations. He hoped that when such men as Pasteur and others of that class had gone into the germ theory sufficiently, they would be able to render great assistance in detecting the sources of the preventable diseases which at present existed.

Captain DOUGLAS GALTON said he quite concurred with what had fallen from Dr. Bartlett and Dr. Alfred Carpenter upon the subject of dust and the removal of dust; but why was it there was so much difficulty in removing the dust, from the dwellings of the poor particularly? It was to a very large extent because in the central parts of London, at least, the whole of the area had been allowed to be built over the backs of the houses, so that there was no possibility of getting into them without a very great deal of trouble. If years ago they had insisted on keeping open spaces behind the houses, and had forbidden the building over of all the open courts and open gardens which there were at the backs of the houses, they would have had much greater facilities for the removal of dust, and have had much better arrangements for the circulation of air. He thought that a great part of the disease rate of the densely inhabited parts of London arose from the impossibility of getting circulation of air and the clearing away of refuse. In the new houses to be built, it was of the greatest importance that this subject should receive the most careful consideration. There should be no building allowed to be erected on any open space within a town without the sanction of the sanitary authorities of that town. He was sorry to observe, in walking round the Exhibition the other day, a model of a proposed building to be erected by the Metropolitan

Railway Company in the Minories. This block of buildings was proposed to be nine stories high; it was to be built in the form of a solid square, across which another block of buildings, of equal height, was to be carried, which left, therefore, two wells of nearly 90 feet deep, and 25 feet wide by 50 feet long, in the centre. That would greatly exclude any possible sunshine from the dwellings in the lower part of the buildings, and naturally prevent any circulation of air whatever. If they were to rebuild London and the dwellings of the poor, they must take the best possible steps to see that in the rebuilding they did not let these past errors again prevail. Dr. Carpenter had suggested that not only should the construction of the houses be approved of by sanitary inspectors, but that every year a sanitary inspector should visit them to see that no alterations had been made; but he could not concur in that view, because if that view had prevailed some years ago, they would have had very little improvement compared with what had since taken place. What he should like to do, and what he believed was the only means of securing real sanitary progress, was to ensure that every member of the community should be adequately educated in sanitary knowledge.

Dr. BERNAYS thought they all ought to be very thankful for the excellent papers and speeches to which they had listened. He wished he had spoken earlier, as the bread had been taken out of his mouth to a great extent. Dr. Tripe, in his admirable paper, had called attention with reference to water that the fittings should be such that it could be drawn straight from the main instead of from the cistern; and after listening to the remarks of so many eminent medical men, none of whom had made any complaint about the water itself, but only against the source, it was obvious tbat the defects which existed might be looked for in the cistern. He had no hesitation whatever in saying that they ought to be very thankful to have so good a water supply as that which was meted out to them. With regard to the dust nuisance, he

agreed with all that had been said if they had only to do with dust, but the chief nuisance in the dust-bin was the vegetable matter. If dust-bins simply contained ashes from the coal, there would be no difficulty about it, but as soon as refuse was introduced the expense of removal was almost beyond belief, and he did not wonder at the remarks which had been made that you could not get the dust removed without paying for it. He had his dust removed every week, and always paid for it without asking any questions. He would suggest that vegetables before coming to London should be stripped of the outside leaves, and, if this were done, there would be very little refuse left to dispose of. At the present time, the people of London suffered more from impure atmosphere than from any other cause.

Mr. JOHN SLATER said it was quite impossible on a subject like this to do more than touch upon the main points which had been alluded to. With regard to the dwellings of the lower classes, which was a subject bristling with difficulties, there could be no doubt at all that any invention which, over an equal area of site, allowed an increased area to internal rooms by diminishing the thickness of the partitions must be a good one, supposing that the partitions were sufficiently solid. It had occurred to his mind that the partition of iron and plaster, to which Mr. Turner had alluded—and he was sorry to say that he had not yet had an opportunity of inspecting it—might not be sufficiently solid, because the houses of the working classes had a good deal of rough usage to submit to. Lath-and-plaster was the worst substance for making the partitions, and he would suggest that if half brick partitions were used, it would be much better. With regard to houses in the metropolitan area, two defects were frequently met with which had not yet been touched upon ; one was the omission of a damp course, and the other the non-ventilation of the space under the ground floor. This was one of the most important questions possible. Everyone knew that you ought to have a sufficient space under the ground floor,

and that the ground ought not to be damp, but unless the space underneath was ventilated, you would have all sorts of bad consequences resulting. With regard to drains in London, they must bear in mind it was frequently utterly impossible to adopt *the best* system of drainage, and therefore they must do the best they could in each individual case. A good deal had been said during the past few years upon the subject of iron pipes for drains, but if he could ensure a good fall, and if all the joints were perfectly sound, and all the pipes put at a sufficient depth under the ground when they passed through the house, so as to avoid the risk of breakage, he would rather have glazed stoneware pipes than iron, though iron did not leave room for so many "ifs." Unfortunately the British workman wanted a great deal of looking after, as he did not always look after the joints, and he had been known, if he broke off the flange of a pipe, instead of getting a new one, to patch it up with mortar or cement. With iron pipes they only had one-third the number of joints, and as the risk of breakage was considerably less, it was desirable in some cases to have them. One sanitary defect which had not been mentioned was the small windows to water-closets and to sink-rooms, for in ninety-nine cases out of a hundred small windows were always put, though these of all places were the ones where full light and ample ventilation was required. Dr. Carpenter had said that he had been told by architects that it was not good to study sanitary science, but as that observation had been replied to by Mr. Robins, he need say no more upon the subject than that all architects were not of that opinion. Mr. Turner had referred to the æsthetic side of sanitation, and as it would take more than the ten minutes allowed to each speaker for him to deal with that question thoroughly, he would only say that sanitary science, and what were called æsthetics, did not always walk hand in hand.

Mr. TOM NANSON observed that Dr. Carpenter had alluded to the advantage of having officials to look after the drains, and to make periodical inspections, but he had

not told them how they were to be obtained. He could assure them that that was a very simple matter, for if three or four persons made up their minds about this, they could ascertain when the next election of vestrymen took place, and then bring forward a candidate who was thoroughly acquainted with sanitary matters, and try to induce him to take a position at the sanitary board. Many of the houses which were being built in the present day, as Mr. Field had said, were built in an insanitary manner; but he would go further and say that, from his experience alone, he found there were not even 10 per cent. of the houses erected which were in a sanitary condition, and houses were being erected from day to day, of an annual rental value of from £25 to £50 or £60 a year, which were really a disgrace. He accounted for that by the simple reason that a man, when he started to build houses as a speculation, directly he became acquainted with the ways, immediately tried to obtain a position on the vestry, and then gravitated to the sewers committee.

Mr. LIGGINS asked how that could be stopped.

Mr. TOM NANSON said it could be done by outvoting the speculative builder. He thought it was now time an earnest endeavour should be made to publicly teach sanitation, as applied in the construction of dwelling-houses; and he appealed to the Council of the Sanitary Institute, who were just now such near neighbours of the South Kensington Science and Art Authorities, to urge upon them to allow the common principles of the science of sanitation to be taught in their schools. He suggested the introduction of some of Mr. Rogers Field's diagrams of disconnecting chambers, etc., on their admirable detail drawings of building construction, as a simple method.

The CHAIRMAN stated that at the present moment that was being done.

Dr. MORGAN said he wished to show how important it was that a house should be cut off from direct communication with the sewer, and to show that the house was not only a danger to itself but to its inmates. In that Exhi-

bition, he was told, there was a model of an insanitary house; but it could not equal the house which he himself took two years ago, for, when he entered it, every possible thing which could be wrong of a sanitary nature existed. If he opened his window to get fresh air, he got sewer-gas, and the sewers ventilated into his larder, besides which a cesspool existed under the pantry. He need hardly say that his predecessor and his family were always ill, and that they left the place upon the ground that it did not suit them. When he entered into possession he was told that the sanitary arrangements were perfectly satisfactory, but no sooner had he got into the house than the whole of his family were taken ill. Upon looking into the matter he found there was no ventilation for the sewers, and that the overflow-pipe from the bath and the drinking-water cistern led directly into the sewers. Some persons might know that in the case of intermittent supply, when the water in the main is turned off, through leakage or other causes, in the main, the pipes would empty themselves, and there was a suck back of air into the water-mains; and one day, upon looking into his cistern, on one side he noticed there was an overflow-pipe from the mains bringing up a discharge of sewer gas, upon the other side being a water-pipe which had just discharged its water and was beginning to suck back the foul air, the consequence being that the water-mains were filled with sewer gas.

Mr. THOMAS BLASHILL suggested that the byelaws relating to sanitation should be so modified as to apply to London. He supposed they were to go on applying such laws as they had to new houses, but very little had been said about applying the law to existing houses. If they were justified in enforcing a certain set of laws on persons who were building, surely the time must arrive when old houses ought to have proper sanitary arrangements. His own opinion was that such time had already arrived, and that there ought to be a periodical inspection of every house. Dr. Tripe had spoken of the necessity of a cistern; he was not prepared to say that under present

arrangements a cistern was not necessary, but he thought they should not be too backward in making demands for improvement in the arrangement of water. They had no cistern with regard to gas, which is drawn direct from the supply-pipe. Water should also be so drawn when required for drinking or cooking, and should not pass through the storage cistern. Whatever improvements or alterations were necessary in order to obtain a constant supply should at once be made. With regard to what had been said about water-waste preventers, he had used many of these which were made by the best manufacturers, but he had always found difficulty with them, and he should be glad to know the name of any good water-waste preventer. A great deal had been said about the collection of dust, and two gentlemen had spoken about the enormous cost of collection; but he begged to say there was nothing enormous about it. The real question was what they paid in the way of rates for the removal of dust. In the parish of Islington, the whole of the expense with regard to the collection of dust, the cleansing of streets, and maintenance of roads and sewers was just about 1s. in the pound, so that it was impossible to manufacture anything enormous out of that, and the extra expense of doing things properly would be a mere bagatelle. The collection of dust ought to be daily. They ought not to be backward in asking for what was wanted for the health of the population on the fanciful idea of the difficulty of doing it, and on account of the expense.

Mr. LIGGINS said they had heard a good deal about the disconnection of house drains with sewers. He lived in a square where there were forty-seven houses, and if he were to disconnect his house, it might result in the sucking away of the water in the trap, which would go into the sewer, and the sewer would empty its foul gas into his area instead of into his house, and he wished to ask the medical gentlemen if all the houses in the square were to do that, whether the atmosphere would not be very much vitiated. Upon the question of dust, he might say that this was not a very easy

thing to dispose of, for the Kensington Vestry had to pay as much as £5 a barge load for its removal.

The CHAIRMAN in closing the discussion said, with regard to the remarks of the last speaker, that what he feared was not likely to happen, as all disconnecting chambers were sealed and ventilated, and consequently the sewer gas was carried above the top of the house. It had been said that very little was being done to remedy defects in old houses, but that was a mistake, for nearly the whole work of the sanitary staff of London was directed to the improvement of such houses. In order to know this, any one had only to take up the reports of Medical Officers of Health: old houses were being dealt with by the thousand every year. With regard to dust-bins, he agreed that, as used, they were an intolerable nuisance, and ought to be abolished, moveable receptacles being substituted. The "dust" should be collected daily, and taken away from London by railway or canal, and the proprietors of railways and canals should be compelled to remove it at reasonable rates. If the "dust" could not be utilised, it should be burned in proper apparatus, constructed for the purpose, to reduce it to a small quantity of innocuous matter. With regard to cisterns, he ventured to say that they would always be required; the analogy which had been drawn between water and gas did not exist, for gas usually was required at night only, whereas water was required at all times. Referring to the evils resulting from the water becoming impure in cisterns from neglect, he mentioned that within the last few days, he had had experience of an outbreak of diphtheria caused by the unprotected state of a cistern; for upon investigation it was found that a number of kittens tied together had been thrown into the water. Rain-water pipes might act efficiently in ventilating drains, but very often the joints were badly made, the consequence being that in many cases sewer gas had escaped near windows, typhoid fever resulting. It was better on the whole to disconnect the rain-water pipe and have independent ventilation. There were

two main points suggested by the discussion to which he would now refer: sanitary difficulties, and sanitary powers. As to sanitary difficulties, no doubt a bad landlord represented a great one. Dwelling-house accommodation in London was far below the requirements of the people, houses and rooms were at a premium, the consequence being that when the poor were turned out of one lodging, they did not know where to go, and thus they were tempted to put up with a number of sanitary defects which they would do much better to report to the authorities and get remedied. But there were bad tenants also, and it was often because there were bad tenants that the landlords were bad. Landlords no doubt had great power in their hands, and many of them would turn out their tenants if they thought they were likely to complain to the sanitary authorities, and the tenants would not complain for fear of having to pay for whatever improvement was effected through the agency of the sanitary authorities. He had known of a case, where the rent of half a dozen small houses had been raised £30 per annum after compulsory improvements which had cost £30 to effect; and it was only the other day that a case was reported of a poor woman whose rent had been raised 6*d.* a week in consequence of the landlord's intention to do something to improve the lodging at a future day. Another difficulty which required consideration was the law's delay. People imagined that vestries had great powers, and that they could do almost anything, but such was not the case. Theoretically the law was fairly good, and much could be done if the defendant person was not obstructive. Mr. Turner had referred to common lodging-houses as being the most perfect in sanitary matters, but this was owing to their being under the supervision of the police, who had considerable and summary powers. As to sanitary powers there were some which might be described as latent, not being exercised, and the sooner they were called into play the better. It was uniformly admitted that a good water supply was essential to health, and if the powers which at present

existed were put into operation they would be, to say the least of it, much better off than they now were. A good deal had been said lately against the water companies, and he thought they had been guilty of great dereliction of duty with regard to cisterns, which were often placed in inaccessible positions, and were constructed of improper materials. Of course, their defence was that they were trading corporations, and did not wish to offend their customers by insisting on their own regulations being carried out. It was within their power to abolish every waste-pipe in the metropolis within three months if they would only put the 14th regulation into force, as they had been constantly urged to do. He thought it would be well that sanitary authorities should have co-ordinate power with the water companies, to enforce the regulations. As to constant supply, he might say that an Act of Parliament was passed thirteen years ago, the object of which was to give this, and there was power latent in the law by which a constant supply could in a short space of time be rendered universal throughout London. To a certain extent the Metropolitan Board of Works was responsible for this constant supply not now existing. That Board excused itself by stating that the regulations were so arbitrary, and that the alterations of the fittings required for constant supply would involve so heavy an outlay, that they were not prepared to impose so great a burden upon householders. It was a question worthy of consideration whether the introduction of a small ferrule in the main might not get over the difficulty by reducing pressure, and so enabling existing fittings to suffice? In the east of London they had constant supply very generally, but in the west they were not by any means so fortunate, though it was true that in houses erected upon new estates, constant supply was given, and he knew that the water companies had announced their intention of gradually spreading it over the whole of the metropolis. Mr. Blashill had referred to the misfortune that in London they had not any byelaws, like the model byelaws of the Local Government

Board, giving directions as to how house drainage ought to be constructed, &c. Such powers as he contemplated existed to a certain extent, but they were not used. The Metropolis Management Act gave power to the Metropolitan Board of Works to make bye-laws for regulating the dimensions, form and mode of construction, and the keeping, cleansing and repairing of the pipes, drains, and other means of communicating with sewers, and the traps and apparatus connected therewith, and for other works of cleansing and disposing of refuse. He ventured to think that if byelaws were made relating to all those points, they would cover nearly everything which had been referred to that afternoon. He hoped that before long the question would be taken up, and that byelaws would be framed. Vestries had no power to frame such byelaws. The only other question to which he would refer was that of the supervision of the houses of the poor. Here again there was a latent power which would soon be brought into operation, for the 35th section of the Sanitary Act of 1866 enabled authorities to make regulations for dealing with certain matters under this head, viz., for the registration and inspection of houses let in lodgings, for fixing the number of persons who might occupy any portion of such houses, for cleansing, ventilation, the separation of the sexes, and various other matters. The Society of Medical Officers of Health many years ago endeavoured to get these powers put into operation, but it was found that there was no means of doing it. The Local Government Board had had the power of declaring the section to be in operation any time during the last eighteen years, but had done so only within the last few months. The Society had lately gone into the matter again, and had framed byelaws for the guidance of the Metropolitan sanitary authorities, which, if they were allowed to be put in force, would no doubt lead to great improvements in the condition of the houses of the poor. The Local Government Board had framed some model byelaws, but they were impracticable. There was no

power, however, to compel the Local Authority to frame regulations, or to compel it to carry out regulations that had received the sanction of the Local Government Board. No doubt larger sanitary powers were required in many respects, but above all what was wanted in England was a little more autocracy in regard to sanitary administration. As to model lodging-houses, they were occupied by an entirely different class of persons to that for which they were originally intended. When the poorer classes were displaced, they generally went to localities which were already overcrowded; the regulations to which he had just referred would enable the sanitary authorities to do something to limit overcrowding, which was a great and sore difficulty. London was increasing in population by some 50,000 a year, and the remedy for many of the evils referred to by the speakers was a system of railways which would take the working people out of town to localities where, for the same amount which they now paid for a single room, they might get a small house and garden. What was desired by those who opposed sanitary improvements was the preservation of their private interests even at the cost of the community; and the remedy was a more autocratic system of government in relation to health matters, such as existed in America, and our democratic colonies, where the community was protected against preventible evils, such as infectious disease, without regard to what was mis-called the liberty of the subject.

Upon the motion of Dr. CHARLES WEST a hearty vote of thanks was accorded to the Chairman.

CONFERENCE ON TUESDAY, JUNE 10, 1884.

1. "*Domestic Sanitation in Rural Districts.*" By GEORGE WILSON, M.D.
2. "*Sanitary Houses for the Working Classes in Urban Districts.*" By H. BOULNOIS, M. Inst. C.E.

CHAIRMAN:

Captain DOUGLAS GALTON, R.E., C.B., F.R.S.
Chairman of Council of the Parkes Museum of Hygiene.

The following papers were read by Dr. Wilson and Mr. Percy Boulnois:—

DOMESTIC SANITATION IN RURAL DISTRICTS.

By GEORGE WILSON, M.D.

IN opening the discussion on this very wide and important subject of Domestic Sanitation in Rural Districts, my share in it will be confined more particularly to the sanitary condition of the labourer's home and its surroundings, and to village sanitation generally, including water supply, refuse removal, and drainage. I shall also endeavour to point out

very briefly to what extent recent public health legislation has enabled sanitary authorities throughout the country to remove or remedy the serious dangers to health which were found to be everywhere prevalent, and to indicate what further changes are required in this direction.

I. *Labourers' Dwellings.*—Some few years ago it was estimated, and the estimate was considered to be fairly within the mark, that a minimum of one-third of the rural homes in Great Britain were unfit for healthy human habitation, and the magnitude of the financial aspect of the question was represented by the statement, that the enormous number of 700,000 hovels which were occupied as dwellings should be pulled down stick and stone, and 700,000 new cottages erected in their stead at a cost of seventy millions sterling. These figures, it must be admitted, were somewhat startling; but they were based on the Report of the Agricultural Commission appointed in 1867 and other official inquiries, and I very much fear that the evidence which is being collected by the present Royal Commission on the housing of the working classes will show that this minimum of one-third still fails to reach a fairly healthy standard for a labourer's dwelling in many parts of the country. From Land's End to John o' Groat's there are hovels to be found in mining districts, in lonely glens, and in seaside villages, so wretchedly bad that comfort, health, or decency become alike impossible. Even in that large tract of Warwickshire with which I am officially connected, I found from a house-to-house survey which I instituted when first appointed, that in some of the villages as many as 10 to 15 per cent. of the cottages contained only one sleeping-room, and about one-half only contained two. And in Warwickshire, according to the Report of the Royal Agricultural Commission, the defects in house-accommodation were not nearly so glaring as in many other counties. Indeed, in some parts, I am glad to say that, owing to the initiative shown by not a few landed proprietors, who recognise that they have public obligations as well as private rights, the cottage accommodation is

remarkably good. But in my district, as elsewhere, many cottages are so old and dilapidated that they require constant patching up to keep them fairly weather proof; some year by year lapse into such a rickety condition that it becomes absolutely necessary to close them; others again, with clay floors on damp sites, can never be considered healthy; while many are so cramped as regards space that there is the greatest difficulty in disposing of the slops and refuse.

Now, although it is quite true that almost all these defects can be dealt with under the provisions of the Public Health Act, I am afraid that a do-nothing policy has been encouraged in most parts of the country, owing mainly to the appointment of medical officers of health at merely nominal salaries, whose private practice hampers them in the full and fair discharge of their public duties. But speaking for my own and other districts, where the health officers are precluded from private practice, and who can, therefore, encourage and support as well as supervise the sanitary inspectors, I feel warranted in saying that the improvement in the sanitary condition of labourers' cottages has been very marked, and as considerable as original faultiness in site and structure will allow. For under the wide term "nuisance," we can order the cleansing and whitewashing of dirty houses, the repair of roofs which let in the wet, the opening of closed or fixed windows, the repair of walls and uneven floors, the removal of closets or pigstyes abutting against outside walls, the laying or repairing of drains, the prevention of dampness as far as possible, and in short the abatement of any defect which is reasonably inferred to be dangerous to health. Then, again, whenever it is found that a cottage cannot be put into decent repair, we can obtain an order to close, but this becomes a very serious question where cottages are scarce, because it only tends to increase the overcrowding elsewhere. Fortunately for health requirements, I believe the population is steadily diminishing in the strictly rural parts of the country, otherwise this question of overcrowd-

ing in consequence of the closing of dilapidated cottages would become much more serious than it is. But when it is remembered that a large proportion of the cottages which are still considered habitable only contain one sleeping-room, it must be conceded that decency cannot be maintained with a growing family, and that overcrowding, apart from the moral aspects of the question, is common enough. Indeed, the wonder is that with such scanty accommodation, the rural labourers are as moral as they are, and were it not for the chinks and crannies which so freely ventilate their dilapidated homes, the dangers would become much more intensified. In dealing with cases of overcrowding, therefore, it is evident that no hard and fast rules can be laid down. The minimum standard of cubical space must not be made too high, and the ages of the children have to be taken into account. With regard to cubical space, it appeared to me, after careful inquiry into the average amount of sleeping accommodation in my own district, that the standard of 200 feet per inmate was as high as it could be raised for families consisting of parents and young children; though I am of opinion that a minimum of 300 cubic feet space, even where good means of ventilation are provided, is little enough for the requirements of health. But in cases where it is found that grown-up children of both sexes sleep in the same room, or in the same room with their parents, the question of cubic space becomes a matter of secondary consideration, and the plea of overcrowding is insisted on in the interests of decency as much as on the score of health. The overcrowding in these cases may be abated by removal of the family to a larger house, or if that is impracticable, by treating the grown-up members as lodgers, and insisting upon their finding suitable lodgings elsewhere.

One of the great obstacles to the improvement of labourers' dwellings in rural districts depends upon the fact that many of the worst class of cottages belong to owners who are really so poor that they can neither afford to build or repair, that others belong to owners who hold

them on leases which are nearly expired, and that many of what are called the old parish houses are vested in Boards of Guardians, who not having the power to build or the funds to repair, are compelled to go into the market and sell the wretched hovels for what they will fetch. Then again, there are many cottages which were originally built on the waste, and for which a merely nominal rent is paid to the lord of the manor. As a rule these are in such a dilapidated condition that they are constantly getting out of repair, and when notice is given to repair or close, it often happens that the lord of the manor prefers closing to repairing, and if no new cottages are built in their stead, the inmates must shift elsewhere.

Another great difficulty in dealing with this question depends upon the fact that the wages of the agricultural labourer do not enable him to pay a rental which would be sufficient to encourage private enterprise in building new cottages, even where land could be readily leased or purchased. A comfortable cottage cannot be built for a less sum than £100, exclusive of site, and the average rent paid by agricultural labourers would not yield a higher return on this outlay than three per cent. But many old cottages can be purchased at such a cheap rate that after having been put into habitable repair they yield a return of as much as 10 to 15 per cent. on the outlay, so that if sanitary authorities had the power to purchase and repair old cottages, and build new ones in districts where the obligations of landowners in this respect are persistently neglected, I think a vast improvement could be speedily effected without unduly increasing the rates. Indeed, when one sees how little need there is for any interference of this kind on well-managed estates, and how the scarcity and wretched condition of labourers' dwellings have become so pronounced through neglect or indifference on other estates, I frankly confess that I think the land should be taxed for the outlay. But into this part of the subject I need not enter farther. Let me rather refer those who wish to make themselves more fully acquainted with this

question of the housing of the poor in rural districts to Dr. Bond's pamphlet on "The Home of the Agricultural Labourer," and to express my conviction that without legislative powers in the direction pointed out by Dr. Bond, it is impossible to mitigate the dangers to health which are more or less persistent in many parts of the country where cottages are very bad or very scarce. But while I admit this legislative necessity, I also admit that great improvements have been effected in districts where the provisions of the Public Health Act have been fairly and firmly enforced, and that nowhere is there any excuse for a do-nothing policy.

Another great impediment to improvement in the house-accommodation of rural districts depends upon the fact that unless the sanitary authorities apply for urban powers, they have got no control over the erection of new cottages, so that jerry-building of the worst description cannot be interfered with, and sanitary evils, more especially in connection with drainage and closet-accommodation, are perpetuated. Indeed, all this is so obvious that it is difficult to conceive why such control over the erection of new houses should not have been conceded to every rural authority by Act of Parliament without the necessity of applying to the Local Government Board for a provisional order, which always entails delay, and is often dispensed with altogether, even in districts where a considerable amount of suburban building is going on. And this control is much more necessary as regards the surroundings than as regards the actual architectural details of the houses themselves. For example, the provisions of the Public Health (Water) Act which were intended to enforce and protect a wholesome water supply in rural districts are often rendered nugatory by the powerlessness of sanitary authorities to interfere. It is all very well to give a certificate to the effect that the water supply of a new cottage is ample and of good quality, but if a cesspool, or deep midden, or leaky drain, has been constructed in the neighbourhood of the well, it only becomes a matter of time before the

well becomes seriously polluted. There ought therefore to be an amendment of the Public Health Act to enable sanitary authorities to enforce bye-laws, not only in respect to new houses, but in respect to the kind and situation of closets, and the proper construction and disconnection of drains. And this applies with equal force to the suburban residence and country mansion. For want of this control over new buildings in rural districts, the most glaring errors and defects in house-sanitation are still committed. Water-closets are erected with the cesspools into which they are intended to discharge often not far from the well; the closets themselves as regards situation and appliances frequently become a source of danger; the drains may be leaky, and often are neither properly disconnected nor ventilated; if the water-closet, as is usual, is supplied with water by means of a force-pump, the cistern which supplies the closet generally also supplies the drinking-water; the soil-pipe is seldom ventilated, or, if it is, the ventilating-pipe is so small that practically it is of little use; and should there be a bath-room, the waste-pipe is almost certain to be laid directly into the soil-pipe or into the drains. Money enough may be lavished on architectural display, but I venture to say that many country architects are still ignorant of the veriest rudiments of sanitation, and hence the great need for extended powers and adequate bye-laws.

II. *Water Supply.*—Although I have no doubt much good has been effected by the provisions of the Public Health (Water) Act, still, as I have already said, the intentions of the Act are often nullified by this inability to interfere with building operations. The usefulness of the Act, too, is limited, inasmuch as it applies only to rural districts, whereas it should be made applicable to all districts, whether urban or rural, not provided with a public water supply. For example, there is a small town in my district which some few years ago severed itself from the union in which it is situated, and was created a local board district, with of course urban powers. But it was without any public water supply, and at the time, none was absolutely

needed. The water supply was derived from wells, and as there was a good deal of building going on, I recommended that application should be made to the Local Government Board for a provisional order to enforce the provisions of the Public Health (Water) Act, which it became impossible to carry out so soon as it ceased to form part of a rural district. The application was of course granted, but it should never have been necessary to make it. Then, again, there are outlying parts in almost all urban districts beyond the reach of the water-mains, which are strictly rural, though within urban boundaries. Surely, it is essential that some supervision ought to be exercised over the water supply of houses built in these outlying corners; and yet, though urban authorities have complete control over the buildings and drainage, they have no power to insist on a pure and plentiful water supply within a reasonable distance before granting a certificate of fitness for occupation.

The other provisions of the Public Health (Water) Act, which enable rural sanitary authorities to enforce a supply of wholesome water to existing houses, and to compel the owners of neighbouring houses to provide a joint supply where necessary, ought to result in much good if honestly and fairly carried out. Where the subsoil water is within easy reach, and it is so in most parts of my district, it is seldom necessary to put these clauses in force, because wells are generally plentiful enough, but the purity of the supply is often endangered by their proximity to deep ash-pits or cesspools, and leaky drains. In such cases, the deep ashpit or cesspool should be regarded as a nuisance dangerous to health, and done away with altogether, and the drains should either be diverted or replaced by open and properly channelled gutters. Sometimes the surrounding soil has become so impregnated with sewage matter that the well must be closed altogether, and a new well sunk in virgin soil, and in these instances the Public Health (Water) Act is undoubtedly of great service. Another source of danger to the water supply of country districts depends upon the fact that the well is seldom puddled to a

sufficient depth to keep out surface impurities, nor is the covering so evenly and imperviously laid as to keep out slop water. It very often happens, too, that a well becomes polluted because it is never cleaned out; indeed, I regard this periodic cleansing of wells so essential that I think every pump-well should be provided with a properly constructed man-hole for purposes of cleansing and inspection, and that the well should be cleansed whenever the water shows any traces of deposit.

I need hardly say that pond or ditch-water, which constitutes the only source of supply to outlying cottages in many parts of the country, should never be regarded as a wholesome supply, and that in all such cases the provisions of the Water Act should be enforced whenever practicable. Open dip-wells, again, are always more or less exposed to pollution, and are specially objectionable when used by more than a single household, on account of the fact that the dip-pails are not always clean.

But in many parts of the country the geological formation is such that wells of any description are out of the question. Villages so situated must be provided with a public water supply, either by storage of the rainfall, or by taking advantage of some neighbouring stream or spring, or by laying deep land drains or adits. Several villages in my own district are provided with a public supply derived from springs situated on rising ground in the neighbourhood, and I may mention, in passing, that in these villages cases of typhoid fever are practically unknown. In a great many other villages public wells are provided, and special care is taken that these wells are kept in good repair, and beyond risk of pollution.

III. *Disposal of Refuse.*—This includes the consideration of three very important items in village sanitation, viz. closet accommodation, scavenging, and drainage. At the date of the passing of the Public Health Act, 1872, the closet accommodation in country villages was of every conceivable description, and often a most fruitful source of nuisance and danger to health. In the older villages it was sometimes

represented by a rough wooden erection, with a hole dug in the ground to receive the excreta ; or more frequently by a sentry-box looking structure stuck somewhere near the far end of the garden, with a fœtid, leaky cesspit behind. Such common privies were often so foul that, even though sufficiently far removed from the house or from the well, they still endangered health, because they could not be used without the risk attending the inhalation of noisome effluvia. In more modern villages, however, and more particularly in suburban districts, the privy and midden ashpit were combined, and, for convenience sake, they were generally erected close to the house and near the well. As a rule, too, the ashpit was made large and deep, so as to permit of huge accumulations,—so deep that, for some time after it was emptied, it continued to be in a filthy sloppy condition, because the surrounding soil drained into it; it was generally uncovered, so that after every shower of rain putrefactive change was increased ; and, in short, was always more or less of a nuisance, owing to inherent structural faults. Then, again, in the few better-class houses provided with water-closets the most serious defects were to be met with, not only in respect to the situation of the closet, but soil-pipes were found to be leaky and unventilated, and the closet discharged either into a covered cesspool from which any gases generated could only escape into the house, or it discharged into a village drain which was not constructed to receive excremental filth. Such briefly are some of the more common varieties of closet accommodation to be met with in rural districts, and, although they can all be dealt with as nuisances under the Public Health Act, it must be admitted, they are common enough still. How then, are these defects to be remedied, legally in the first instance, and with a due regard at all times to efficiency and cost? Perhaps I shall best answer this question by quoting from a small pamphlet of mine on "Sanitary Defects in Villages and Country Districts, and How to Remedy Them," published in 1876:—

"Take, for example, the primitive wooden structure with

the hole dug in the ground to receive the excreta. As a rule, this kind of privy accommodation is only met with when the cottage itself is old and dilapidated; so that it would be a sheer waste of money to insist on the erection of a new and substantial structure. All that the law demands is to fairly satisfy the requirements of health and decency, and this can be accomplished in the great majority of instances by a very trifling outlay. Let the hole be cleaned out and filled in with fresh gravel or clay, and such other alterations made that a galvanised iron pail or box can be readily inserted beneath the seat to receive the excreta. This, of course, should be regularly emptied into the garden, and to obviate nuisance dry earth or sifted ashes should be thrown into the pail at least once a day, and in sufficient quantity to keep the excreta covered. If the seat is hinged there will be no difficulty in removing the pail or in throwing the ashes into it without dirtying the seat. Or take the old-fashioned privy, with its fœtid cesspit behind. This can be readily converted into an inoffensive privy and ashpit combined, by filling up the cesspit to the level of the ground; paving or cementing the filled area, walling it in and covering it as an ashpit; raising the floor of the privy a step, and with it the seat; and placing a flagstone sloping backwards beneath the seat, so that the excreta may be readily covered with the sifted ashes or dry earth thrown into the ashpit. Or the ashpit may be dispensed with, and, after filling up the cesspit, the privy may be readily converted into a pail-closet. To sift the ashes either a common wire riddle may be used, or one or other of the cinder-sifters which have lately been devised. But whatever alterations may be adopted in addition to those required for privacy and ventilation, the great desideratum is to keep the excreta dry and prevent undue accumulation. Large, deep, and uncovered midden-steads, or ashpits, connected with privies are always a source of nuisance. When they are nearly empty the surrounding soil drains into them in wet weather, so that for the time being they become open offensive cesspools,

and when full they permit of soakage into the surrounding soil. Every ashpit, therefore, connected with a privy should be little, if at all, below the level of the ground ; it should be cemented or made otherwise water-tight, and should be covered (a sloping tarred wooden covering hooked on to the back of the privy will do) to keep out the rain. Moreover, it should be of limited capacity, to prevent undue accumulation, and thereby necessitate frequent removal of the contents. Sometimes, in order to keep the contents more or less dry, the ashpit is drained ; but, apart from the liability to chokage of the drain and the nuisances arising from the admission of liquid excremental filth, drainage of the ashpit should be prohibited altogether, because, if the ashes do not keep the excreta dry and inoffensive, the system is a failure."

These were the instructions which I laid down for the guidance of the sanitary inspectors in my own district, and it will be seen that every possible latitude is allowed with regard to the way in which nuisances connected with privy accommodation may be removed. In the suburban parts and in increasing villages where new schemes of drainage have been carried out, the option is given to convert these privies into pail-closets, or into water-closets, but pail-closets are only recommended where there is no difficulty as regards scavenging. The water-closet which is found to answer best in districts where there is no public water supply, is the simple pan-closet, with syphon bend and ventilating shaft, and I always recommend that the slop-water be used for flushing purposes. Of course this applies only to outside closets; where the water-closet is inside the house, it should be provided with proper cisternage and other appliances.

In dealing with closet accommodation in rural districts the Public Health Act confers ample powers on sanitary authorities for enforcing such alterations as are required for the abatement of nuisance, and these alterations can be carried out as a rule without entailing any serious outlay. Nor do I think it necessary to recommend any of the

excellent patent earth-closets which have been devised, partly because they add to the expense, and partly, too, because I find that from neglect they do not possess any advantages over the ordinary pail system. In addition to the pail for the excreta, all that is required is a box for the dry earth or sifted ashes, and a small shovel with which to throw them into the pail.

In those rural districts which have obtained urban powers, the bye-laws with respect to the closet accommodation of new houses are now so carefully drawn up that nuisance or danger to water supply is scarcely possible if scavenging is properly attended to. The vast majority of rural districts, however, have not applied for these powers, and without bye-laws they have no control over new buildings, so that the serious defects to which I have referred continue to crop up as building goes on.

But even when the closet accommodation is of a kind to satisfy all reasonable sanitary requirements, it need hardly be said that cleanliness of the surroundings cannot be maintained without due attention to scavenging. The pail system possesses the advantage that it does not permit of filth accumulating near dwellings, and where there is sufficient garden space the householder should be held responsible for the scavenging. But where there is no sufficient garden space, then I hold that the landlord ought to make arrangements with some one to do the scavenging regularly, or should provide some convenient place on which the householder may deposit his refuse. For exceptional cases such as these, it has been recommended that the sanitary authority should provide a "muck-acre;" but in villages where garden space is so generally insufficient, I think the sanitary authority ought to undertake the scavenging either by contract or otherwise. Judging from my own experience, however, I am of opinion that for the great majority of villages public scavenging is not only unnecessary, but to insist upon it is unreasonable. No doubt a village in which every cottage is provided with a patent earth-closet regularly supplied with dry earth

and scavenged by the sanitary authority, ought to be a model village as regards outside cleanliness, but if every cottage has also its garden, I feel sure the manure would be greatly missed, and I question very much whether the scavenging would not be as well done if left to the cottagers themselves. By all means let us insist on cleanliness, but do not let us render the enactments for the removal of nuisances a dead letter by undertaking to do all the dirty work for lazy people, when such work can be readily attended to by themselves. The solid refuse, then, should be disposed of in the gardens where the garden space is sufficient, and where that is insufficient, it must in any case be removed from the premises at stated times, and not allowed to accumulate so as to befoul the air or endanger the water supply. The bulk of serious nuisances with which rural sanitary authorities have to deal refer especially to the reconstruction of the closet accommodation, and the disposal of the solid refuse, and in districts where the provisions of the Public Health Act have been steadily carried out, there is no doubt that the improvement in village cleanliness has been very marked, and this has been accompanied by a very gratifying reduction in the sick-rate and death-rate from filth-diseases.

But in addition to the disposal of filth and other solid refuse, there still remains the serious difficulty of satisfactorily disposing of the slops and refuse-water, and in villages of any size this implies a system of drainage of some sort. The system which is generally found to prevail is of the following description:—The shallow road drains which were intended in the first instance to carry off the surface-water, and which for the most part are either constructed of common drain-pipes, or loosely laid bricks or stones, have been converted into open sewers by conveying into them the badly laid and open-jointed drains leading from almost every house or group of houses in the village. If there be a water-course near the village, the drainage discharges into the stream by one or more outlets, as the case may be. Should it happen, however, that the village is some distance

from the stream, then we find the slops discharging into open ditches by the roadside or into field-ditches in the neighbourhood of houses, and thereby often giving rise to filthy nuisances in every direction. This description, of course, only applies to the worst drained villages, but in almost all of them some of these defects are to be met with. Sometimes the drains lead into a dumb-well, and if there is no well for drinking water near, this is a tolerably safe and ready method of getting rid of slops, but the multiplication of dumb-wells or cesspools in compact villages would always be attended with the greatest danger, and ought to be prohibited as much as possible. In small villages, where the houses are scattered, no general system of drainage is required if the garden space is sufficient; but in compact villages of any size it is essential to get rid of the slops by channels of some sort, and drains should always be preferred to open gutters. So far as the health of a village is concerned, the drainage may be regarded as of two kinds. If the soil is at all damp it should be drained to secure dryness, and if the slops cannot be got rid of without creating nuisance a system of drainage will be required to dispose of them satisfactorily. But much will depend on local conditions. If the village is stationary or decaying, I hold that no expensive system is required, but if the village is steadily increasing, it then becomes necessary to carry out a complete system which will be ample enough for the growing requirements of the particular locality.

But supposing that a village is fairly well drained, or requires to be drained, how is the sewage or slop-water to be ultimately treated? That, too, will depend very much upon local circumstances. If the village drains into a large stream without creating any nuisance, and the stream is not used for drinking purposes lower down, there is no sanitary reason to interfere; or if the village drains into one or more open field ditches, sufficiently far removed from houses or roads, catch-pits will generally suffice; but if there be nuisance at the outfall or risk of water pollution, then the sewage should be purified if possible by irrigation

or sub-irrigation. But in whatever way the slops be ultimately disposed of, it is essential that they should be conveyed by one or more outlets to a safe distance, and not be allowed to accumulate in stagnant ditches by the road-side, or in back gardens, to pollute the air by the foul smells which they emit, and endanger the water supply.

Then, too, I think that sanitary authorities should have the power of preventing water-closets from draining into surface-drains in small villages, and of excluding all liquid refuse from slaughter-houses or other places which might tend to increase the outlay in drainage, and very much increase the difficulty of dealing with the sewage at the outfall.

There are many other phases of sanitary work in rural districts on which I should like to dwell, but I trust those upon which I have touched will afford ample scope for profitable discussion. While there is abundant evidence that sound sanitary progress is being made in some parts of the country, it must also be admitted that in large tracts the provisions of the Public Health Act, and other Acts applying to country districts, are still in abeyance, and this, as I have already said, is in great measure owing to the general want of a properly organised public health service. Medical officers of health should be trained men, and be debarred from private practice, while surveyors and sanitary inspectors should hold a certificate either from the Sanitary Institute or some other examining body as to their fitness to discharge the duties required of them. But in addition to independent and well-qualified officials, we want extended legal powers for rural districts ;—powers to purchase and build in parts where it can be proved that the cottage accommodation is alike bad and scanty, and above all we want urban powers with suitable bye-laws to control building operations, and prevent the sanitary defects which are continually cropping up, whether it be in the erection of cottage, homestead, or country mansion.

SANITARY HOUSES FOR THE WORKING CLASSES IN URBAN DISTRICTS.

By H. PERCY BOULNOIS, M. Inst. C.E.

ONE of the most important social problems of the day is to provide adequate, convenient, and, above all, cheap sanitary dwelling accommodation for those who are known as the working classes. As a rule, the amount of rent payable by these classes is out of proportion to their income; for instance, a man receiving 18*s.* a week in wages pays, perhaps, 3*s.* or 3*s.* 6*d.* a week for the use of two rooms, and it would be almost impossible for him to secure a house for himself and family under a rental of about 5*s.* per week, whereas the proportion of rent to income for the middle classes is usually about 1 to 10, and that for the richer classes still less.

This excessive rent to those who have to closely watch every penny of their expenditure in order to make two ends meet, causes them to seek cheaper accommodation in flats and rookeries; they thus lose that self-respect which the possession of a separate house would give, and communism, except where it is vigilantly watched, leads to dirt, dissipation, and disease.

Upon this point I cannot do better than quote the words of Dr. Davies, the M. O. H. for Bristol, who, after twelve years' experience, thus speaks of dwellings on the block system:—*

"Our experience of typhus fever in Bristol in 1865 was that, if introduced into the lower part of a large house containing many families in separate apartments, it almost invariably ascended and affected every compartment above the room first infected before it was extinguished. We have found that different families having privies, or privy

* *Vide* Proceedings of the Association of Municipal and Sanitary Engineers and Surveyors. Vol. iv. p. 63 *et seq.*

landings or corridors in common generally have their diseases in common, especially small-pox and maculated typhus."

And after further observations tending to show that dwellings in flats are a mistake, he says :—

"I am of opinion that all so-called model lodging-houses, if so arranged as to multiply the number of inhabitants on an acre, or place different families in floors, or, as I should call them, flats, one family above another, or by corridors, common areas, common passages, whether separated by pervious iron railing or not, or have offices in common for washing or other domestic duties, or in any way approach a system of domestic communism, are an error and a blunder."

We are bound to respect opinions like these, coming from a man with the hardly won experience that Dr. Davies has, but the difficulties of providing a different description of dwelling for these classes are threefold :—

First, the value of land in all large towns.

Secondly, the desire of the workman to be near his work ; and

Thirdly, the expense of building suitable separate dwellings at a low but remunerative rent.

It will be my endeavour in this Paper to meet some of these difficulties, and explain how they can be overcome.

The first two difficulties must be taken together, as they so closely impinge upon one another. It would of course be impossible to provide separate cottage dwellings in the most frequented and valuable districts of any town, but with the present cheap locomotion available by train, tram-car or omnibus, the population can be far more distributed than was formerly possible ; nor should it be necessary either to acquire so much land on which to erect the cottage dwelling as hitherto, as I hope to show in the course of this Paper, and consequently the cost of purchase of land for this purpose should not be prohibitive. The danger to be apprehended in thus distributing the population is that cheap and bad houses may be erected for its

accommodation outside the boundary over which the urban authority have jurisdiction, especially where that authority have bye-laws in force of so strict a character as to almost prevent the erection of small houses at small cost. In this case the results would be discouraging, as if there are no bye-laws regulating the erection of buildings, houses would be constructed with privies close to wells, upon improper sites, with bad materials, and with no provision for the removal of the house refuse, and all the evils consequent upon the want of that useful jurisdiction by which we, as a self-governing body, impose certain restrictions upon each other for our mutual welfare. Disease would soon be rife in such a district, and speedily spread to the community it is our wish to protect.

Now with regard to the erection of the small class of house suitable for the habitation of the working man and his family, and within his means.

I am afraid what I am about to write will be of little use to the individual known as the jerry builder. He builds usually only to sell, his houses are mortgaged before they are wall plate high; he lives a hand to mouth existence, manufacturers will not trust him, and he is at the tender mercies of middlemen, who charge him exorbitantly for his bricks, his drain-pipes, his lime, his timber, his slates, and above all for his ironmongery, in order to cover their risk in the matter. No cheap and good houses will ever be built so long as materials have to be purchased so dearly. But I will now proceed to point out the requirements of a house which can be built at very moderate cost, and be as sanitarily perfect as modern science will admit.

The site should be clear of all filth, it should not be an old refuse tip; and if marshy it must be drained.

The whole of the site of the house within its walls should be covered with a layer of cement concrete, 6 inches thick, to prevent the ground air rising into it.

No basements should be allowed, they are thoroughly objectionable for a house of this description, and even for a better class of house they should only be allowed to store

wine in, and not be used as kitchens or sculleries. They are difficult to ventilate, to keep dry, to light, and to drain, and their construction should be always looked upon with great disfavour, especially for a small class of house, as there is no saying how soon they may be occupied even as bedrooms!

The external walls of the house should be constructed hollow by means of two $4\frac{1}{2}$-inch walls, with a space of about $2\frac{1}{2}$ inches between, proper damp courses of asphalte or slates being provided. The benefit of walls built in this manner is undoubted, and the extra expense over the ordinary method is but trifling. In many districts walls of concrete can be most economically constructed, and this description of building is certainly gaining in favour.

The house may contain either four or six rooms. In the former case the ground floor would have parlour and kitchen, the upper floor two bedrooms; in the latter the kitchen could be built as a tenement wing at the back, with a small bedroom over it.

The height of the rooms should be 8 feet, the windows being sash hung and opening at the top, and if any special means of ventilating the rooms could be introduced which would be beyond the tampering powers of the inmates, so much the better, if it did not make the rooms too cold or draughty.

The fact, however, must not be lost sight of, that "man abhors ventilation," especially if it lowers the temperature of the room he is in, or causes a draught. This renders ventilation unpopular, especially with those classes who are unable to raise the temperature of their bodies by food or fuel. One favourable means of good and cheap ventilation is by a simple construction of the fireplace, the back and sides being made hollow, with air-bricks on the floor-level, the fireplace itself being merely constructed by three or four iron bars built in across the front.

Great care should be exercised in laying the floors that the battens should be close jointed. Grooved and tongued battens are rather expensive, but ordinary floors can be

laid with well-seasoned boards, so as to have close joints. Open joints are highly unsanitary. The dirt and dust fall through, and accumulate for ages, and form a fine nest to nurture any disease germs that may be swept or washed through the crevices between the boards.

The walls of the room should be painted, or distempered bright, cheerful colours. Papers harbour dirt, and are seldom removed when a fresh paper is laid on. Good distemper will not rub off, and is much cheaper than wall paper, besides acting as a disinfectant, and is beautifully clean and sweet.

The roof of the house should be flat, covered with cement concrete, and a thin coating of genuine mastic asphalte. This flat roof can be approached from the top landing by a flight of easy steps or stairs. Not only does such a roof give a more even temperature to the rooms under it, but it affords a ready escape for the inmates of the house in case of fire. It is also cheaper of construction than an ordinary slated or tiled roof, and it serves as a pleasant place for recreation, or even as a garden or drying-ground, which is not so likely from its position to become contaminated with refuse or other filth as would be a similar convenience at the back of the dwelling on the ground level. Such a roof also gives a splendid vantage point from whence a fireman can direct his hose upon any adjacent burning building, an advantage which those who have had to cope with the extinction of fires can readily appreciate.

At the back of the house there should be a courtyard paved with asphalte, not the usual nondescript so-called garden, which is made the receptacle of half the filth of the house, and where in addition are frequently kept sundry offensive smelling animals. The amount of space necessary for a real garden is usually quite out of the question, where the first cost of the land and the buildings have to be considered.

A small, cleanly kept, well paved, open space at the back of a dwelling is far healthier than a larger but foul smelling one; and in the majority of hundreds of small houses I

have visited, I have found that the larger spaces behind dwellings of this class are but depots for storing filth. It is also difficult to ensure that the space thus provided will not be built upon at some future period, and the object of securing a sufficiency of pure air space is thus defeated. A narrow street at the back of the house is a great advantage if it is well lighted and constantly cleansed. The scavengers' cart can pass through this street, thus avoiding the necessity of carrying the house refuse through the house to it, and the main sewer, water, and gas services can also be laid in it, the advantages being obvious.

Plenty of air space should be found in the front of the house, as no street should be permitted to be constructed of less than 40 feet in width ; the pathways should be broad and well paved. Public parks and playgrounds, tastily planted boulevards or wide streets, and free recreation, such as music and flower shows, should tempt the people out to get the fresh air that is so beneficial to them.

Upon the back yard I have described should open the doors of the wash-house, the scullery, the w.c., and any other offices there may be. No fixed dustbin should be allowed ; the daily refuse should be placed in a galvanised iron bucket or pail, and the scavengers' cart should pass each day at or about some fixed hour, when the occupant of the house could easily carry out the bucket, and empty its contents into the cart. Fixed dustbins, except for large establishments, are a dangerous nuisance, as they are difficult to empty and to clean.

Next in importance to that of the question of the water supply, the position and condition of the drain and w.c. of every house may be considered as the keynotes upon which the sanitary condition of that house turns.

For this reason the w.c. should be at the back of the house, and open on to the yard so as to ensure isolation, its floor may be a continuation of the asphalte paving of the yard, the pan and apparatus cannot be too simple ; there are a great number of the clean flush type of closets to be seen in this Exhibition, without valves, pans

or impediments of any kind, and one of these could be used advantageously and economically. The water supply for flushing must be ample, and come from a sufficient height, and through an inch and a-half pipe at least, a bucket of water thrown in by hand is a better flush than that so often given by one of the now so generally used two-gallon waste-preventing cisterns, through too small a pipe and insufficient head.

The main sewer should, if possible, be at the back of the house for two important reasons: first, because the drain need not then pass under the house, and secondly, that of economy, as less length of drain is required.

If it is unavoidable that the drain should pass under the house, then it must be completely surrounded by good cement concrete and relieving arches turned to any walls passing over it. In America, iron pipes are used under houses, but this would add to the cost of the cheap house I am describing. The drain must, of course, be efficiently trapped and severed from that common enemy the public sewer.

Although it is sometimes argued that a water seal is not a safeguard, it is the best with which we are at present acquainted, and if supplemented, as it of course must be, by a fresh current of air constantly passing through the house drain, no evil consequences need be feared. For this purpose the trap should be a "Buchan" or other similar syphon with a good cascade action to prevent chokage, its position being guided by circumstances, the drain should not end at the closet, but be carried up open its full diameter to a safe position above the house, an inlet for fresh air being provided on the house side of the trap. There are many simple methods of effecting this which are too numerous to mention in a Paper of this description, but a diagram which I produce will explain one or two modifications of the system.

The sink in the scullery or kitchen should be one of the many glazed stoneware patterns, not stone or cement, and the pipe leading from it should empty into a pit covered

with a grating and provided with a syphon, or, still better, to a simple form of grease-trap, which can be purchased for a few shillings; the rain water down-pipes must of course also empty themselves on to or near open gratings, and must on no account be connected directly with the drain.

The water supply should be constant, so as to avoid the necessity of storage; but if it is unfortunately intermittent, then the cistern must be placed in such a position as to be easily seen and cleansed, as it is surprising into what a filthy state these receptacles can get before it is discovered; under no circumstances should the same cistern be used for flushing the W.C., and for household purposes, and the waste or overflow should empty through the wall into the open, and not into the drain.

The above requirements for a sanitary house are all perfectly simple, and are not prohibitive of strict economy in its erection; why is it, therefore, that they are not built? The reasons are many and various, but I believe the principal ones may be summarised as follows:—

(1) The avarice of the builder. So long as he can sell or let cheap houses, built with hidden defects, so long will they continue to be erected.

(2) The ignorance both of builders and tenants. If the latter were educated in the simplest rudiments of structural sanitation at the Board schools, and in other manners, the former would soon learn that their ignorance or cupidity did not pay, and they would very speedily find out the remedy.

(3) The want of sufficient supervision by the officers of the sanitary authority. This arises in no way from the fault of the officers themselves, but from the insufficiency of the staff employed. Any one practically acquainted with the science of building will know that if a builder or one of his men wish to evade or to scamp any particular portion of his work, what close watching and irksome prying and investigation are necessary, even with a clerk of works constantly on the look-out. How much more difficult is it then for the officer of the sanitary authority, even where

they really wish to see their bye-laws enforced, to watch so closely as to prevent any of the 99 clauses of the model bye-laws being infringed.

A change is certainly required in the present machinery and manner of the inspection of buildings in course of erection, and until a large staff of inspectors or sanitary police, or some such officials, are employed, very little real advancement will be made with the sanitation of buildings. To secure this adequate supervision, a fee might be charged by the sanitary authority to the builder or owner, and although any provision which might increase the cost of construction of the house is undesirable, the extra cost of such inspection would be too small to be appreciable, while the advantages would be not only considerable to the community, as tending to improve the public health, but also to the owner of the house, as ensuring good honest work for his money. In larger and more expensive buildings, this supervision is generally exercised by the architect, but as a rule no architect is employed to supervise the erection of small houses, though in many cases he may have prepared the plans, and the builder is accordingly left almost entirely to his own devices with frequently unfortunate results.

DISCUSSION.

Prof. Sir HENRY ACLAND, K.C.B., M.D., said he came to the conference principally to testify his respect and homage for that great institution, which those, like the Chairman and himself, who had known in various ways something of Sanitary work for the last forty years, were filled with astonishment and satisfaction to witness this day. He desired to pay his respect to the Chairman for his attention to this great subject, and to Dr. Wilson, than whom there was no one better acquainted with the wants of the population in the rural districts. He might remark that he left an Examination for medical degrees at Oxford

that afternoon whilst all the candidates were actually writing a paper on the subject of Public Health; for he was glad to say that no physician would ever graduate in Oxford who had not passed not only a scientific but a practical examination in Sanitary Subjects. The two papers they had just heard were in a certain sense typical of the present position of this matter. They rather left the general principles and bristled with details of the facts which had to be attended to. They had now done with the question of the importance of sanitary knowledge. That was a thing of the past, for everybody acknowledged the importance. The only question which remained, was what was to be done, how it was to be done, and how much was to be enforced. On the last two points he was sorry to say they were still in some ignorance. Coming up in the train he was much amused at reading an article in the leading journal full of amusing satire on the condition of Oxford with respect to its water supply, and it richly deserved it. The reason of this was that the subject had been progressive, and there had not been adequate knowledge on the part of those who had in their hands the framing of the laws to guide them, even if they had the power. For several years they had had the power on the whole, and notwithstanding what they heard from Dr. Wilson and Mr. Boulnois, he believed that if the powers they possessed were utilised by an intelligent people there would be very little to complain of. He was tolerably familiar with the condition of the rural districts in many parts of England, and had also some knowledge of certain portions of the east of London. The Chairman might be said to represent the widest and most difficult parts of this problem, for it was he who built the Herbert Hospital many years ago, and Dr. Wilson had drawn attention to many of the rural details. But it was not knowledge that was wanted, either of principles or details, so much as the knowledge of how to get those things done which were required. To take one small case as an example: Dr. Wilson had referred to the necessity for

buckets being provided for wells, because dirty buckets were now constantly made use of. He mentioned such a thing as this, because if he must venture to make a criticism concerning the Central Administration, it would be that it was not always those who drafted Acts of Parliament, who knew, as Dr. Wilson did, exactly the little matters—"the linch-pins"—which had to be attended to—which were not very many—but which were of the utmost importance. Mr. Boulnois said it was desirable that instruction in Sanitary matters should be given in Board schools. This was a pregnant and sound observation. He was satisfied that no compulsory laws would ever get this matter right, it could only be done by the increasing knowledge of the people. There was in the Exhibition a great department about which he had heard unwise jokes, the educational apparatus, but it was simply by education that the thing would be understood. It was not by compulsion that the people would be kept clean, but by their personal knowledge and their personal character. Character was gained by striving and struggling with difficulties. High character was often found in the poorest populations. But no struggling with difficulties, no suffering in illness not relieved, would educate the people, or keep them strong, or give them knowledge. They must get true education, and he believed that Exhibition would educate them in some things as the world never had been educated before. There was, no doubt, the need of power to do things as a community, which as individuals they could not do. No individual could ever enforce, execute, or maintain a great system of drainage; it must be done by the rates, and done under the law. This must be carried out by compulsion. All individual exertion would rest with the people, but the carrying out of great works must depend upon improving the education of the legislators. Before sitting down he would add that economy was necessary in this matter, and that those who saw the evil and loss by disease which resulted from unsanitary conditions, were bound not to endeavour to enforce

on the people anything not absolutely necessary. He sincerely hoped that in the Exhibition not only what was necessary would be learnt, but also, and in many cases, how little was sufficient to make a house decent, and to keep it as it should be kept, without endeavouring to impose on the owners or occupiers costly things difficult to obtain, and complicated things which it was difficult to keep in order.

Sir ROBERT RAWLINSON, C.B., said that he regretted he had not had the privilege of hearing the papers, but agreed most heartily with Sir Henry Acland that sanitary progress must be a matter not of State compulsion but of education; and he would appeal to the ladies present on that subject, because it was one in which female energy must come to the front. There were several causes from which the working man's house might be rendered unfit for habitation: the man himself might be worthless; he might not take the whole of his wages home to his wife; but if the house was slatternly, if it was a slovenly, dirty place, the chief blame rested on the woman. It was her duty to keep her house clean, and where a working man's wife was industrious, attentive, and cleanly, and took care that her husband had a comfortable meal as far as her means would allow, that was one of the roots of sanitary progress. The extravagance of sanitary works had been alluded to by the last speaker, and he was bound to tell the meeting that sanitary plans and estimates came before him, which often staggered him by their extravagance. Instead of the works being more economical, he was positively appalled at the estimates brought before him for sewerage and drainage. Only that week he had to examine an estimate for the sewerage of a population not exceeding 4000, the amount of which was 75,000*l*. Again, Local Boards were independent in a measure, when the General Board had once given its sanction; and these Local Boards throughout the country—for there was one everywhere now—who were elected by the ratepayers, were sometimes constituted of persons who

were either ignorant of the duties they had to perform, or careless. The works were let to a contractor. The local surveyor, again, might be either ignorant or careless, and the Local Board did not take care to see how the work was going on, what the extras were, and consequently the estimates were exceeded by a third, a half, and sometimes were even doubled. Then, if disputes arose, the law made provision by which they were to be settled under the Lands Clauses Consolidation Act, and anything more roundabout, or extravagant than the process under that Act never existed. He had abstracted cases recently where it cost 75*l.* to settle a dispute of 50*l.*; where there was a dispute of 1000*l.*, the costs ran up to 350*l.*; but in a recent case to settle a claim for extras amounting to about 700*l.* the costs exceeded 5000*l.* These things were constantly coming before him, and he did not exactly see what remedy could be applied. Englishmen claimed to be free to do as they liked, to exercise local self-government; and if a Local Board, or if two men dispute about anything in the shape of a contract they must settle it by arbitration. But when it was once brought to arbitration there was no limit to the employment of what were technically termed experts; and he was sorry to say you could get professional experts who would appear on either side, and of course as both sides could not be right they were willing to swear black on one side or white on the other. He mentioned these things because he knew he was speaking to gentlemen who were leaders in this great sanitary movement, and he was pouring forth his grumble and exhibiting his helplessness in the hope that it might be taken up earnestly by Sanitary Associations, and that in some way a remedy might be devised. For every evil there ought to be a remedy, and he thought he could see the way in which many of these disputes might be settled economically and with great advantage; but when he had ventured, in the pursuance of his duty, to bring about a settlement of this kind, he had been told at head-quarters that he had done a very unofficial thing, and that the law

did not justify him in so doing. To give an example he was lately holding an inquiry about certain road improvements in a district in Devonshire which was growing up from a mere rural village into a seaside summer resort. There were several parties concerned ; and the scheme was for widening the old rural woods, taking off the frontages to throw into the street, and he was there to carry out the inquiry preliminary to a provisional order to enable the Local Board to buy the sites compulsorily, as in no case could they agree satisfactorily with the owners. He held the inquiry ; and then told the parties, who happened to be all present, that he should report in favour of the improvements, and that if they opposed further, the next thing would be, that the Local Board would have power to take the land compulsorily, which they could only do after a legal trial, an arbitrator would be appointed, there would be witnesses on both sides, and it was impossible to say what the expenses would be. Then he went on to say that he was a surveyor who understood values, and if all the parties would consent to abide by his decision he would go out on to the roads, look at all the properties and give his decision, and the whole thing might be settled before he left the town without costing them sixpence. He was happy to say that that was accomplished, but it was not legal. There was nothing absolutely illegal in it, so long as all parties consented, but the law had made no provision for such a thing. But he knew in many cases, if the Inspectors of the Local Board were empowered by Parliament, and if it was part of their duty to put such a proposition when they held an inquiry, and ask the parties if they would accept such a decision as finally binding, thousands of pounds might be saved and nobody would be any worse, in fact everybody would be better. There was no advantage whatever in extravagant expenditure, and if 1000*l.* were unnecessarily spent in settling a dispute, you might just as well throw so much money into the middle of the Atlantic. For his part he did not believe that even the witnesses were benefited by the fees they received.

Dr. W. N. THURSFIELD, said he wished to add his testimony to what had been already said of the limited usefulness of the Public Health (Water) Act. Good water was a most desirable thing, but bad water was very common, especially in isolated houses in the rural districts. It was one of those defects with reference to which there was less direct compulsory power than in almost anything else. There was a general idea that where a house was unprovided with a proper supply of potable water within reasonable distance the Sanitary Authority had power to call on those responsible to provide the water. Theoretically they had, but when they came to enforce their powers there was a difficulty. The law provided that if the person responsible for providing water failed to do so after notice, the course for the Sanitary Authority was not to summon the person responsible to show cause why it had not been done, but to carry out the work themselves and recover the expense. But the expense which could be so recovered was strictly limited, in ordinary cases, to a few shillings over 8*l.*; and the utmost they could recover, with the special consent of the Local Government Board, was a little over 12*l.* in the case of any one house Now, considering the uncertainty and expense attending such an operation as well sinking, it was not to be wondered at that he had not been able to find any case where these compulsory powers had been put in force. He had known thousands of cases where the prestige of the Act had been sufficient, and where notices served under it had been followed by the provision of a proper water supply. The Act introduced by Mr. Brown was also doing much good, by securing that no new house could be occupied in a rural district, unless a certificate had been obtained that there was available, within a reasonable distance, a good supply of wholesome water. The appreciation of the necessity for, and the precautions essential in order to obtain, good water was very much a matter of education, like everything else connected with sanitary work, and as a rule where water was obtainable at all by well sinking, good water could be as easily

obtained as bad; and the reason why bad water was the rule and not the exception, was that no care was exercised in selecting the spot at which to sink the well. The only thought appeared to be convenience of access, and no care was taken to protect the well from surface filtration, and bad water was often obtained where good water could be had for the same expense.

Dr. WOODFORD said, the admirable paper by Dr. Wilson covered nearly the whole ground on which he could offer any remarks; but one point had struck him which he had long thought would, if carried out, be a valuable improvement in the Public Health Act, namely, the abolition of the existing distinction between the powers of urban and of rural authorities. His own district included eight rural and four urban districts, and after much delay, limited urban powers had been obtained for five of the former, being in fact the five in which alone building was going on to any great extent; but those powers were not granted until a great part of the mischief had been done. Houses had been built almost to the full extent of the requirements of the respective neighbourhoods, and sometimes beyond, often in the worst style of jerry-building; and then, when the mischief was done, and when he had again and again brought the matter under the consideration of the various sanitary authorities, they were induced to apply for urban powers. In twelve months time those powers were granted, and in another twelve months they got the bye-laws sanctioned; but by that time no further houses were wanted, and none were likely to be wanted for some years. Had this distinction not existed in the first instance, and had the Sanitary Authorities of the rural districts possessed power under the Public Health Act to regulate the construction of new houses, they would have been able to deal with the matter *ab initio*, and the mischief would have been prevented. Then with regard to the definition of the word "nuisance." In the 91st section of the Public Health Act there were certain things specified as being nuisances, but some most important sanitary shortcomings

were omitted, as to which (directly resulting injury to health being often incapable of proof), it was very difficult to persuade a rural Bench that they were in themselves nuisances with which they had power to deal. That had occurred with him so frequently as to induce him practically to keep as far away from the rural magisterial Bench as he could, and to rely more on talking, and a little gentle bullying, to do his work. Whenever any alteration were made in the Public Health Act, he trusted this would not be overlooked. If it were distinctly provided that wherever a house had such sanitary fittings as by their mode of connection with drains, sewers, or cesspits permitted the ingress of foul air into it, or as were likely to pollute the water through their improper construction or their position as regards the well, the Sanitary Authority should have power to interfere, it would be a very valuable addition to their powers, and would enable them to deal with many cases of unsanitary conditions which were the cause of much ill health, not only amongst the poor but amongst those higher in the social scale. While the sanitary defects of cottages were bad enough, they were, with the exceptions of defective ventilation, damp, and dilapidation (the last two being not unfrequently held by "Petty Sessions" as not coming within the scope of the Public Health Act) for the most part outside the houses; whilst in country mansions and suburban villas the sanitary defects were within as well as without, and you frequently found a low state of health clearly traceable to those conditions. He should like also to add his voice in support of Sir Henry Acland's remarks as to the extreme importance and value of sanitary instruction to the young as well as to adults. Until the elements of sanitary knowledge were taught in the primary schools, and the children of the poor were made to understand and value personal cleanliness, wholesome houses and surroundings, and the necessity of utterly eschewing the abominable habit, so common in rural districts, of depositing all their refuse within the shortest possible distance of the back door, they

could not expect any material improvement in the appreciation or practice of domestic sanitation in the years to come.

Dr. ALFRED CARPENTER said he would refer at once to the necessity for education which had been so well alluded to already. It was perfectly useless to have bye-laws or sanitary regulations without they, who had to see that they were enforced, themselves understood the object for which they were imposed. Twenty years ago he endeavoured to press upon the attention of his own Local Authority some of these first principles which were now generally becoming understood; and the Local Board was greatly in advance of public opinion, and had bye-laws which carried out all those regulations which had been so strongly insisted upon by the readers of the Papers. These bye-laws were enacted, but the people did not understand the use of them, and they were not carried into effect, the laws were dead letters. Even the inspectors did not understand the principles upon which they were based, and consequently looked upon them as fads, and did not see that they were carried out. So long as this state of things continued, as a matter of course, in spite of such regulations being on the statute book, unhealthy conditions continued. No doubt the great cost of sanitary work was a great impediment to progress, because when certain arrangements were proposed to be carried out in his own district, and the time for elections came round the owners and small proprietors went round to their own tenants, and told them they must take care not to elect such and such men to Local Boards, or otherwise the rents would be raised, because they could not afford to carry out these improvements or alterations without increasing the rents; and the result was obstruction, arising entirely from ignorance of what was wanted. As a rule, correct sanitary principles were simple, and were not anything like so expensive as they were proposed to be made by those who were sometimes called sanitary engineers, who went in for making a big job instead of simply carry-

ing out health principles. Again, many people were always calling out for Parliament or for the State to do a deal of work which belonged to the occupier to do; he thought they should set their faces against this principle of compulsion being carried to an extreme, and by the action of the local authorities doing the work; but should rather make the people themselves do it. He contended, it was a mistake for a few people in a district to raise a great cry for more power, for the purpose of compelling other people to do what was best; and it was much better to educate the people, to show them that they were only asked to do what was right and in their own interests, and then compulsion would be unnecessary, and much expense would be saved. The question of cubical space was alluded to in one of the papers, and no doubt it was very important; but certain rules were laid down which, if carried out, would render the first cost of cottage property so great that it would be almost impossible to have the people housed. This question depended much more on ventilation than on the size of the rooms. For the purpose of keeping rooms healthy, the main thing requisite was a perfect and continuous inspection by the Local Authority, so that the necessary arrangements for healthy conditions should not be set aside. The inhabitants of cottage houses were not very fond of having those arrangements which tended to prevent the warmth of the building being kept up, and therefore they stopped ventilation whenever they could, and the same thing applied to all the other arrangements; if they were not continually looked after, it was quite certain that in a short time they would be put on one side. Constant inspection was required to keep the people up to the mark, by persuasion if possible, and if not by summoning them at the petty sessions. The more these matters were considered and discussed by the public themselves, the better chance would there be of enlisting public opinion in their favour. He had had his windows broken for attempting to teach the people before they were ready to be taught, which convinced him that, if the

regulations of the Local Authority were too far in advance of public opinion, they could not be carried out.

Sir THOMAS ACLAND, Bart., M.P., said he came there to learn, and he certainly learnt that great progress was being made in the minds of those who had been sanitary workers, and they were really now looking at the fundamental work which had to be done, which was to educate the public. He was asked by the Chairman to speak from the point of view of a landowner, and he must acknowledge that he belonged to a class which required a great deal of education; but they were not all quite so stupid as some people thought. He was not a sporting man himself, but he must say that very few men knew as much about their properties as the masters of fox-hounds. He could answer for one or two at any rate who knew every hole and corner of their property, and a great deal about the people who lived there. He was not one of those who thought that land was to be treated like any other chattel; there were certain duties connected with the ownership of land, and if those duties were not discharged the nation had a right to take steps that they should be discharged. He had had a great advantage in the way of getting information on this subject, both from the Chairman and from Sir Robert Rawlinson, to whom everyone connected with landed property had the greatest reason to be grateful. In one particular case he had assisted him greatly to obtain a pure water supply very economically. He would also remark that Mr. Brown, Member of Parliament for Wenlock, was entitled to a great deal of gratitude for the amount of pains he took to get the Act passed for providing the water supply. Sir Robert Rawlinson also contributed very much to the efforts of the Committee, and so did Mr. Clutton, one of the surveyors who had been referred to. A great outcry was sometimes raised against centralisation, which very often arose from ignorance and sometimes from worse than ignorance. There was great jealousy in some Local Boards of the central office. But he remembered Mr. Tom Taylor, when he was head of the office, said his constant duty was to prevent people in

the country borrowing money of posterity and spending it amongst themselves, and very often doing so very wastefully. Centralisation was wanted first of all to teach the local sanitary authorities and their officers what was already known to men of science, and so to circulate the knowledge through the different localities. Then considerable powers at headquarters were required not so much to enforce compulsory powers as to prevent foolish and absurd plans being carried out, and to take care that the matter should be thoroughly well considered and understood with competent knowledge, before the public were taxed, or posterity burdened with expenditure which only benefited a few persons in the present day. One thing which had not been referred to was the qualifications of local public officers who were to make the landowners do their duty. He did not agree entirely with those who were for appointing scientific gentlemen to go down into the country with strong powers. He had the greatest respect for the scientific men who came to teach them, and he was glad to see that the tone of the majority seemed to be that their business was not so much to compel as to convince. He did not quite agree with those who said that Officers of Health should not have private practice, for he believed that the well-educated medical men of the country were capable of doing perhaps a great deal more good than some of the scientific gentlemen who had never got into practice. What was wanted was to support those gentlemen, to inspect them, and see they did their work, and then a healthy feeling of public opinion would be created, which would prevent any loss falling upon them from doing their duty. Then, with regard to the qualifications of other persons, he wanted to see some statutory power which should require an educational qualification for all relieving officers, nuisance inspectors and surveyors, and others employed by Boards of Guardians. He heard the remark made in the country by a gentleman who was not a political liberal: that there is one indispensable qualification for appointment under some boards, viz., that the candidate must have

failed in managing his own business before he is entrusted with public business. He did not know that they wanted any kind of scientific examinations, but there should be some test to show that the individual had had a good general education and understood those fundamental principles which lay at the foundation of the work he had to do. Then, in case a man might have been unlucky enough not to have gone to a good school and had a certificate, there might be some committee under the Civil Service Commissioners which should be required to see whether the man understood thoroughly the practical and scientific work he had to do. He cordially supported the opinion that it was education which must be looked to, and he hoped the effect of that Exhibition would be to diffuse that knowledge throughout the country.

Dr. ALFRED CARPENTER asked permission to state that the Sanitary Institute of Great Britain, which was a body embracing the majority of the principal sanitarians of the country, had appointed a Court of Examiners, consisting of eight gentlemen, all eminent in the sanitary world, who were prepared to examine persons who proposed to take the office either of Surveyor or Inspector of Nuisances, and before these men received the Certificate of the Sanitary Institute, they had to prove to their examiner's satisfaction that they were competent to perform the duties they undertook, and he could speak confidently of the thoroughness of that examination.

Mr. E. L. JACOB agreed with Dr. Wilson, that the distinction at present existing between so-called rural and urban districts in one or two points was very objectionable, and ought to be removed, especially in the power which urban authorities possessed, but rural authorities did not, to make bye-laws regulating the sanitary arrangements of new houses; consequently the rural sanitary authorities had to stand by and see houses erected with every defect conceivable, and then afterwards endeavour, often in vain, to get them remedied. One reason which made it desirable to alter the law was this, that although

the Local Government Board had power to confer these urban powers on rural authorities, they had lately adopted the policy of refusing to do so; and although, seven years ago, in one union in the county of Surrey, with which he was connected, they granted these urban powers over new buildings for every parish, some of which had only 200 or 300 inhabitants, they had lately refused to grant them in another union in the county, stating that it was not their practice to give these powers for parishes of that size, showing plainly that a change of policy had taken place. As the result of that, building was going on extensively in some of those parishes, and houses were being built which were in all respects as bad as they could be. As regards the Public Health (Water) Act, the one thing which limited its application very much was that the maximum cost which the sanitary authority was entitled to put the owner to, in providing a water supply, was too low, in some cases 8*l.*, and in others 13*l.*, and there were many districts where wells could not be sunk for that money. He was thankful to say that in many rural districts the villages were getting the water-supply in the way in which the Rivers Pollution Prevention Commissioners indicated in their sixth Report, viz., by the extension of the mains of water companies in towns to the rural districts. Companies were being formed, with Acts of Parliament, for supplying groups of parishes, the waterworks were established in the most suitable parish, and the mains were carried in all directions; and thus these villages obtained the supply much cheaper than they could in any other way. As regards "scavengering," and the systematic removal of the contents of cesspits in villages; where there were no sewers, the pail system was no doubt the best, if the Sanitary Authorities would contract for weekly attention to these pails. It was a great misfortune that they did not do so more, and were not more willing to spend money in this particular work. In many villages, in Surrey, he had persuaded the authorities to undertake it, with very excellent results. Dr. Wilson had alluded to a dampness of the subsoil, and

the benefits arising from the subsoil-drainage, which was a most important point; but he regretted to say that in the present state of the law Sanitary Authorities had not power to carry it out. He could name two villages, with a very damp subsoil, where the level of the subterranean water was certainly only a foot or two below the surface, and where the Sanitary Authority was desirous to put in subsoil drains, but, doubting their powers to do so, applied to the Local Government Board, and were told that they could not. When the Public Health Act was amended, that was an important point to be considered. With regard to the education of the people, to which some of the previous speakers had alluded, he would say that, although the practical work of inspectors and medical officers was in many respects very discouraging, partly because of the careless habits of the poor, and partly because of the reluctance of Sanitary Authorities to spend money on works; there was one gratifying phase of their work, and that was the education of the people, which, they felt, was going on through their instrumentality in every part of the country. There was no part of his work which he discharged with more pleasure to himself, and (he hoped) with more profit to the people, than the systematic inspection of his district, conversing with the people, teaching them what he could of the benefits of cleanliness, and looking after their sanitary arrangements, which, if left to themselves, they were apt to neglect.

Dr. C. E. SAUNDERS said the disadvantage of the distinction between rural and urban authorities was very marked. In his district six out of seven of the Rural Sanitary Authorities had urban powers, but the seventh had not, and a speculative builder had come to the very verge of a city of considerable size and put up some very trumpery buildings, but he had taken great care to build the closets in the city district, where they were bound so far to relieve him. A good deal had been said about education, and he quite agreed as to the importance of it, but they must not lose sight of the fact that they did

require greater powers than they already had, and he thought the time had now come when an amendment of the Act of 1875 should be considered. Sir Robert Rawlinson had referred to the very easy way in which important questions could be dealt with by gentlemen like himself, of great skill and knowledge, and he ventured to think that very often the Local Government Board might do good work if they would, but very often when questions were asked they gave evasive answers and said, "It is not our business to advise you; you must go to a lawyer or call in an engineer;" which of course involved very great cost. As they had all this knowledge at fingers ends, it seemed rather niggardly that they should begrudge giving it. With regard to the Public Health (Water) Act, though it had defects, it must not be forgotten that under it every new house built must be supplied with water.

Dr. ARMISTEAD said, with regard to the Public Health (Water) Act, he remembered a discussion at the Society of Arts, at which Mr. A. H. Brown, M.P., who took great part in the passing of the Act, was present, and then said that a common supply could be made for two or more houses, and hoped that would occur in many cases. Now he had tried in several instances to carry this out. The Sanitary Authority had taken the necessary steps one by one, sending the notices Forms A. and B., and even got tenders for the work, when a member of the Rural Sanitary Authority suggested that they should write to the Local Government Board and ask if they had power to group cottages or houses, and to recover the apportioned costs supposing they carried out the work. The reply received was to the effect that if the water could not be supplied within a reasonable distance of each house separately considered, at a cost not exceeding that limited by section 3 of the Public Health (Water) Act, 1878, the Rural Sanitary Authority could not compulsorily provide a supply at the cost of the owners, although the cost per house under the apportionment might be within the prescribed limit. In another Union, where they had almost got to the point of

taking a test case into Court, the reply was, "objection might probably be taken on the ground that in the case of each house being taken by itself, a supply could not be provided at a cost coming within the limit fixed." Now it was simply absurd in most rural districts to think of providing an adequate supply of water, where none already exists, for *8l. 13s. 4d.*, but if a common supply could be provided for a group of houses, in many instances the Act might be made available, and the cost. per cottage, when apportioned might be considerably less than that sum.

Mr. PHILLIP NUNN said there was no doubt that the working man had to pay a much larger rent in proportion than the class above him, and this was very prejudicial to the public health, and tended to overcrowding. In his district he feared there was a tendency for the health of the working class to become deteriorated by the high price at which land was sold, and it seemed to him that one of the practical points for a conference of this kind to consider, was whether any means could be devised by which land could be bought compulsorily by the Local Authority, on which suitable houses could be erected, which could be occupied by working men at a fair rent in proportion to their income. He believed that Medical Officers of Health generally would bear him out in the statement, that in all towns in urban districts this condition of overcrowding from high rent, and the high price of land, was one of the great causes tending to injure the health of the community. With regard to education in schools, it was no doubt very important, but they must first educate the authorities. Committees of schools generally knew nothing and cared less about sanitary matters in schools. They must encourage the clergymen and the committee to take an interest in these things; and not until that was done could they expect to educate the children properly in sanitary matters. Then popular health maxims and pictorial illustrations might be used to advantage, and thus the rising generation might be educated.

Dr. DUDFIELD said people often wondered at the per-

sistency with which certain tradesmen advertised their goods; in explanation it had been said that you must get an advertisement read 200 times before the reader would become conscious of its contents. For the same reason it was absolutely necessary to go on preaching and teaching, talking and writing, not merely to the public, but to sanitary authorities also, in order to get them to know and to do their duty. There were many powers latent in the law which might be put into operation with advantage; and the reason many things they would like to have done were not done, was because Officers of Health were a little too diffident about repeating the same thing over and over again in their reports. If clergymen had the same diffidence, churchgoers would have much shorter sermons than they were generally favoured with. He admitted the great ignorance of the public, aye, and of many gentlemen who served conscientiously on public boards also, but without sufficient knowledge to enable them to do their duty efficiently. It was a prime duty, therefore, of an Officer of Health to keep on telling these gentlemen the same things over and over again as long as necessary. For that reason he was in the habit year after year of repeating the same things in his reports; and no doubt many of his colleagues in reading those reports, would say they had seen this before, that such and such a passage was just what he had said last year, and so on; and it was true; he did not intend such repetitions for them, but for his own Board, and by degrees, in that way, in course of time, he got matters thoroughly understood and carried through. So with regard to the education of the people in sanitary matters: they must educate the children before they could expect any satisfactory result. Eight to 13*l.* has been spoken of as the limit of the expenditure which could be enforced in the country for providing a water-supply to a house; but what was the fact in London? There was no power to get water laid on for domestic purposes if it cost more than 3*d.* a week or 13*s.* per year. But fortunately they had another power; they could compel an owner to lay

water on to the water-closet, and for that purpose there was no limit in regard to expense, and in that way they got over the difficulty, because if water was laid on to the water-closet it was available for domestic purposes generally. He agreed with the observation of Mr. Boulnois with regard to ventilation, and the necessity for providing it automatically. If ventilation depended on human agency to be kept going, it would certainly be neglected. Arrangements should be made so that the air brought into the house might be warmed, for it was of little use having fires if you chilled the atmosphere by bringing in cold air. By a very simple plan, easy of introduction in houses in course of erection, fresh air might be brought in and warmed, and all the heat of the fire utilised to preserve warmth as well as to ventilate the room. With regard to the question of the Medical Officer of Health being debarred from private practice, there was a great deal to be said on both sides. There was a great difference between the position of such a man in a large urban district and in a country district. Medical practitioners in country districts were thrown very largely on their own resources, and were as a rule exceedingly well qualified, men of independent minds, capable of meeting almost any emergency. He did not think it would be possible to any large extent to restrict Medical Officers of Health in rural districts from private practice ; but in large towns and in London, if they were remunerated sufficiently, it would be very desirable that Officers of Health should be restricted to their official duties. To pay them well would cost very little. In London, for instance, there were forty Officers of Health, quite enough too ; and what would 40,000*l.* a-year be for the sanitary service of London in that particular department? But, as a matter of fact, salaries varied from a minimum, almost too ridiculous to mention, to a maximum which was not enough, in London, to enable a medical man to maintain the position which the dignity of his office required, and so private practice of some kind was the rule. There were no means of compelling a Board to give any particular salary, and, except in very rare

instances, the position of medical officer was not a career for a medical man. There were gentlemen in the room who held fairly good appointments, in the country; they had combined districts; but the combination might be broken up at any time, and where would they be then? With one exception, he believed there was not a gentleman present who held an appointment for a longer period than five years. That gentleman gave up a position in London to go into the country; he had a good appointment, and got on very well with his joint-committee; but if there were to be a quarrel among the constituent authorities he might suffer. The only other point he would refer to was the suggestion that Local Authorities ought to have power to erect houses; that was a thing he should be glad to see carried out. The supervision of buildings in course of erection by Sanitary Authorities might suffice; but if they had the power to acquire gasworks and waterworks, they might also have the power to house the people. Even in that matter, he believed there were some powers latent in the law which enabled Sanitary Authorities to build, but hitherto they had never exercised them. He referred to the Labouring Classes Lodging Houses Acts, 1851, 1866 and 1867, passed for the purpose of providing lodging-houses for the labouring classes. Gas supply yielded a profit, and water supply yielded a profit; not long ago he saw that a Local Authority had in the course of a few years applied more than 200,000*l*. of profits obtained in this way towards the reduction of the rates. He did not doubt that sanitary houses could be built in the country to pay a larger percentage of interest than the Local Authority would have to pay for the money they borrowed for the purpose, and in that way a great improvement might be effected. If a certain number of good examples were set people would work up to them; as it was, there were very few persons who set a good example, and therefore people went on repeating the old mistakes. He wished there were more power under bye-laws, and he also wished there were power to compel Sanitary

Authorities to do their duty in making and enforcing bye-laws.

The CHAIRMAN, in summing up the discussion, said this subject divided itself rather into two heads; the provision of houses for the poor in country districts, and of houses in urban or town districts. Mr. Boulnois had given an interesting description of the house which he recommended, which had reference rather to what might be called suburban districts than to those entirely in the country. No doubt they all agreed as to what a sanitary house was, and what kind of drainage and water supply ought to be given to it, but there were points of construction which would differ very materially in certain localities. For instance, where land was so very dear as it was in Newcastle, Birmingham, and Manchester, and where the dwellings must be in the centre of the town, it is hopeless to expect to build each separate dwelling in its own area; they must have dwellings built one above the other, and he did not at all agree with the opinion that flats, if laid out in a proper manner, need be unhealthy, nor that even a hospital if built in the centre of a town might not be built so as to be healthy, although it might have more than two, three, or four stories. If you prevented communication between the several stories by isolating the staircase, you might have a perfectly healthy building. No doubt similarly the conditions with regard to warming might be different in town to what they were in the country. In a town where you had large blocks, like the Peabody Buildings, or other model buildings, it would be very desirable to abolish the smoke nuisance by getting rid of the fire-places in each room, and much as he had always advocated the use of a fireplace for the purposes of ventilation, he could still see that it was perfectly possible by steam heating such as was adopted in the United States, or by the use of gas, to supply each room with warmth and ventilation, and prevent the pollution of the air which was now caused by coal fires. But when you came to consider how the money was to be found for these buildings, and this after

all was the great difficulty, there were two distinct conditions to be borne in mind. In the country districts the houses were really required for the cultivation of the land. A house for the farm labourer was as much an appendage of the farm as the stable. Good stables were built for the horses, and if the land were to be cultivated in a proper manner good houses ought to be built for the labourers, so that they might be healthy, and be able to do their work properly. Even in cities he was not sure that it would not be desirable for manufacturers to build houses for their workmen, as had been done at Mulhouse, and in various parts of the Continent, where the workman was made almost an integral part of the factory; he got a good house built for him and shared in the year's profits. If that were done more generally they would have much more contented workmen, and the difficulties of the sanitary problem would be much diminished. They were told that more powers should be given to Sanitary Authorities, and that a new Act should be passed; and no doubt it was true that more powers might be advantageous, but he was certain that if Sanitary Authorities would fully perform their duties all over the country, and exercise the powers they now possessed to their fullest extent in an intelligent manner, there would be very few unsanitary houses in England.

Then there was the very important question of how to replace the houses in certain districts where they were very defective, and yet where the Medical Officer of Health was unable to condemn them because he was afraid of turning out the population and causing overcrowding elsewhere. There were many cases in which it possibly might be right that the rates should be charged with the erection of dwellings, but they must proceed in that matter with great circumspection. They could not hope to remedy the great evils which had arisen from the neglect of centuries in the course of two or three, or even ten or fifteen years. It would take time; but the most hopeful symptom was that people themselves were gradually becoming alive to this great and important question, and it was by education alone that

they could really grapple with it. The Health Exhibition had been devised by the Prince of Wales for the purpose of conveying that education in as practical a way as possible to the nation; that is to say, by making the people of England themselves convinced of the vastness of the subject and the necessity of making themselves masters of it. It was most gratifying to see how fully it was being appreciated, and he believed the results would have a very lasting effect on the improvement of the sanitary administration of the country.

Sir ROBERT RAWLINSON, C.B., moved a vote of thanks to the Chairman, who, he said, was one of the foremost and oldest sanitarians. He hoped that this Exhibition and these Conferences would tend to enlighten the general public on questions of sanitary science, and show that it was necessarily the foundation of civilisation. He had heard in that room some very just and good remarks, and he had heard some which showed comparative ignorance of what might or might not be done. One gentlemen said the law made no provision for subsoil drainage, but he could only say that was news to him. He knew no reason why, if subsoil drainage were necessary, it could not be carried out, and if an application were made to the Local Government Board for a loan to carry it out, he was quite sure it would be granted. With regard to the difficulty of obtaining proper plans, he would say there was no great witchcraft in sanitary science, as the best sanitary works were exceedingly simple, and there was not a lady or gentlemen present who might not learn very shortly to devise and superintend the carrying out of rural cottage drainage. Where you had to deal with houses in streets or towns, a properly educated surveyor must be called in, but where any ladies or gentlemen living in the country saw about them single cottages having no sanitary appliances, a well-educated lady, setting her mind fairly to work, might very easily master the subject sufficiently to instruct any ordinary workman to put the cottage in as good a sanitary condition as it was capable of being put.

Conference on Wednesday, June 11, 1884.

"*Industrial Diseases.*" By John Syer Bristowe, M.D., F.R.S.

Chairman:

Edwin Chadwick, Esq., C.B.,

Vice-President of the Sanitary Institute of Great Britain.

The following paper was read by Dr. John Syer Bristowe, F.R.S.

INDUSTRIAL DISEASES.

By John Syer Bristowe, M.D., F.R.S.

The investigation of the causes of disease is a subject which has ever engaged, and still engages, the choicest intellects in the profession of medicine. For not only does it present the highest scientific fascination, but it is fully recognised that it is in the discovery of the causes of disease that our best hopes of dealing successfully with diseases, either in curing, in mitigating, or in preventing them, reside. When it was proved that scurvy, that

direful scourge of sailors in bygone times, was due simply to deprivation of vegetable food, both the means of preventing it and the method of curing it became obvious. When once it was established that certain fatal infectious diseases of the lower animals were due to specific vegetable organisms, which could be separated from the tissues of the body and cultivated apart from them, the possibility naturally suggested itself that by appropriate methods of cultivation they might be so far robbed of their virulence as to impart or inoculate milder forms of disease, which (in accordance with the analogies afforded by the relation of cow-pox to small-pox, and the protection which one attack of any infectious fever generally gives against subsequent attacks of the same disease) should hold their subjects harmless for the future. I need scarcely remind you of the brilliant results which, by the skilful pursuit of this idea, M. Pasteur has achieved in relation to the anthrax fever of cattle and chicken cholera, or remark on the promise which they give that other human diseases besides small-pox shall some day be robbed of much of their loathsomeness and danger. When also it became apparent that septicæmia and pyæmia, the frequent causes of death after accidents, after operations, and in the lying-in room, were due alone to the inoculation of the system through the wounded surfaces with the septic organisms or bacteria, which abound everywhere and are the agents in putrefactive processes, the need of absolute cleanliness and of the most careful protection of susceptible parts from accidental inoculation from without followed as a corollary. And the introduction of so-called Listerism into surgical practice has deprived the gravest operations of much of their danger, and has rendered possible the frequent successful performance of operations which formerly one scarcely dared to attempt.

As civilisation has advanced, and manufacturing and other processes have developed in order to meet the growing wants of mankind, dangers formerly unknown have arisen, accidents of special kinds have become common, and diseases new to our nosology have sprung up amongst

us—accidents and diseases dependent on the new conditions under which, in certain circumstances, men have found themselves placed. I do not, of course, mean to say that civilisation has tended to increase sickness and shorten life, for the reverse of this is known to be the fact. No doubt many causes of disease and injury to which our savage, or less civilised, ancestors were exposed, have wholly or in part ceased to be operative, and by so much have we been the gainers; but, none the less, new and often unsuspected sources of mischief have from time to time appeared in association with conditions, mainly beneficial, determined by our progress in art, in science, and in luxury.

Among the dangers here referred to must be included: first, accidental injuries, such as mining accidents, accidents caused by machinery, accidents due to the ignition of explosive compounds, and the like; second, the dangers arising from the temptations to which special occupations expose the persons engaged in them, such as those of alcoholic intemperance incidental to potmen and commercial travellers; and third, diseases due to poisonous or other influences incidental to certain occupations, and which can only be escaped, if escaped at all, by the adoption of special precautionary measures. It is this last subject with which alone I have to deal on the present occasion.

One of the most interesting groups of industrial diseases is that in which injurious effects arise from the slow action of metallic or other inorganic substances, or their derivatives, upon the system.

Chronic lead-poisoning.—Metallic lead is probably inert; and even its salts, though generally regarded as poisons, may, for the most part, be taken even in large quantities without material injury to the taker. It is very different, however, with respect to the salts of lead habitually received into the system, even in minute proportion. It would be difficult to enumerate all the conditions under which chronic lead-poisoning is apt to occur. All those who have to do

with metallic lead, such as lead-miners, plumbers, type-founders, and manufacturers of lead toys, occasionally suffer. All persons concerned in making glass, in glazing pottery and the like, in which operations the oxides of lead are employed, are liable to become affected. But the chief sufferers are those who manufacture, or employ in their work, the carbonate of lead; especially therefore, painters, plumbers, glaziers, glazed-card manufacturers and lacquerers. It is important to note, however, that lead-poisoning is not limited to operatives in lead, but that, owing to the extensive employment of this metal and of its derivatives, the general public are by no means free from danger; and that isolated cases, or groups of cases, of plumbism, referable sometimes to the drinking of water stored in lead cisterns, sometimes to the use of hair-washes or cosmetics containing lead, sometimes even to the long-continued employment of lead as a medicine, and to other sources of contamination which need not now be specified, are often brought under the notice of medical men.

The symptoms of chronic lead-poisoning are for the most part very striking, and generally quite unmistakable. The most common, and on the whole the most important, are a pecular form of affection of the bowels, and a peculiar form of paralysis. Lead colic (as it is termed) is usually the earlier in its advent. It is characterised by intense griping abdominal pain, coming on in paroxysms, and associated with hardness and retraction of the abdominal muscles, nausea or sickness, and almost insuperable constipation. Lead palsy, in its simplest form, attacks those muscles of the forearm which extend the wrist, the thumb, and the first joints of the other four fingers, so that when the forearm is held out prone the hand drops powerless at the wrist, and the fingers droop so as to form nearly a right angle with the rest of the hand. This condition is known as "dropped wrist." Further the affected muscles are tender and irritable, and rapidly waste. The palsy, however, is not in all cases confined to these muscles. Sometimes the upper arm suffers as well as the forearm;

sometimes the muscles of the legs are implicated ; and occasionally indeed the muscles of the trunk, including those of respiration, become involved. But, besides these chief consequences of chronic plumbism other phenomena due to the same causes are observed. A peculiar form of cachexia, characterised by anæmia or bloodlessness, a sallow or earthy tint of the skin, derangement of the digestive organs and debility, is generally present in a greater or less degree ; and in connection therewith may be mentioned the fact of the occurrence of a characteristic blue line along the margins of the gums at their junction with the teeth. Occasionally also, late in the progress of the disease, blindness, epileptiform fits, dementia, or some other form of madness makes its appearance. A curious but very important fact was observed by Dr. Garrod some years ago, and its truth has been confirmed by subsequent observers, namely, that there is a remarkable relation between gout and chronic lead-poisoning ; that the victims of the latter affection become disproportionately liable to gout, and that persons of gouty tendency are specially prone to suffer from exposure to lead.

The immediate cause of the various phenomena above described is the entrance of lead in some one of its forms into the system ; its deposition in the tissues ; and its specific deleterious action on the organs which chiefly suffer. The poison gains access either by the respiratory organs, owing to the inhalation of vapour or dust ; or by the stomach, in consequence of the impregnation of food or drink ; or, possibly also, in certain cases by cutaneous absorption.

In most instances the injurious effects of lead are readily recovered from if the case be taken early, and if the sufferer give up the employment which exposed him to danger. If, however, he persist in exposing himself, either the colic may prove fatal, or the paralysis becomes established and spreads ; and finally he dies either from the effects of cachexia, from extension of paralysis to vital parts, or from the supervention of symptoms of cerebral disease.

It is probably impossible that workers with at any rate

some forms of lead should be rendered wholly free from liability to lead-poisoning. But it is clear that much may be done to minimise danger. "The first principles in lead-works are the inculcation of cleanliness; avoiding eating with unwashed hands, or in working clothes, or in workshops; moist-grinding; free ventilation; precautions against dust rising, or wearing flannel respirators when this is unavoidable; with occasional doses of sulphate of magnesia, acidulated with sulphuric acid." Similar precautionary measures should of course be taken by painters, and by all who are habitually exposed. It is seriously worth while for those who inherit a tendency to gout to consider twice before entering upon occupations which expose those who follow them to lead-poisoning.

Chronic copper poisoning.—Pure copper, like pure lead, is probably inert. But the salts of this metal are much more poisonous than those of lead; and acute poisoning by them is not only characteristic in its symptoms, but liable to end fatally. It is somewhat curious, therefore, that characteristic poisonous effects from the long continued absorption of cuprous compounds are not nearly so common as those due to lead, and indeed that by some their occurrence is denied. It is certain that copper salts gain entrance into the system by the same routes and methods as lead salts, that they become deposited in the tissues, and that a characteristic greenish or purplish line, somewhat resembling that due to lead, is apt to appear at the edge of the gums. But here all positive knowledge ceases. It is said, and seems not improbable, that workers exposed to the fumes or dust of cuprous salts are liable to suffer from nausea, sickness, diarrhœa, and other symptoms of gastro-intestinal irritation. And there is good evidence that brass-founders are subject to periodical febrile attacks in which colic, or intestinal disturbance, is followed by rigors, and to which the name of "brass-founders' ague" has been given. But it is held that the symptoms are due, not to copper, but to the zinc or arsenic, which is com-

bined with the copper. The subject of chronic copper poisoning derives a special interest from the fact that copper is, or perhaps I should rather say has often been, designedly mixed with pickles and preserved vegetables to give them colour. I believe that no clear evidence has yet been adduced of the injurious effect of copper taken under such circumstances. Nevertheless, it must always be borne in mind that copper salts are poisons; that, if they be taken accidentally in excess, acute and even dangerous symptoms may result; and that hence it is probably as important, in the case of copper as in that of lead, that those who are exposed to danger should adopt the precautions of cleanliness, and the like, which have already been specified.

Chronic arsenical poisoning is not uncommon in consequence of the inhalation of arsenical vapours or arsenical dust. "Those who are chiefly exposed to this form of poisoning are persons employed in the manufacture of pigments, paper-hangers and decorators, artificial flower manufacturers, milliners, persons exposed to the fumes of heated metals, particularly zinc and brass, manufacturers of dyes and leather-dressers." Further, persons living in rooms papered with arsenical paper are very liable to suffer. The substance to which chronic poisoning is mainly due is arsenite of copper, commonly known as Scheele's or emerald green, which was formerly largely used as a pigment, and is still thus used to some extent. Dr. Guy, in the year 1862, investigated the effects of this preparation as they were shown in the industries in which they were chiefly employed, and ascertained that it was mainly in connection with the colouring of paper and of artificial leaves, fruits and flowers, that chronic poisoning occurred. The main symptoms are congestion or inflammation of the conjunctivæ, with intolerance of light and œdema of the eyelids; a sense of heat and tightness in the throat; a feeling of heat and pain in the pit of the stomach; together with more or less feverishness, thirst, loss of appetite and

nausea. Following on these, or associated with them, may be developed salivation, sickness and diarrhœa, dryness of skin, with erythematous or eczematous eruptions, œdema of the extremities, nervous disturbance, feebleness and tremor of the limbs, gradual emaciation, and finally death. The disease, however, rarely proves fatal, inasmuch as its nature is generally recognised long before the symptoms have become dangerous, and the proper means of arresting it have been adopted in time. Yet occasionally the symptoms (which are liable to variation) are misleading; and if at the same time the source of poisoning be not detected, serious consequences are likely to ensue. It may be added that cutaneous symptoms are among the earliest and most common of the effects of arsenic, being produced by local irritation, and that, although not generally dangerous, they are a source of infinite discomfort and annoyance. There seems to be no doubt, on the other hand, that persons may readily accustom themselves to the habitual use of arsenic in increasing quantities, until so much is taken at a time as would poison any ordinary person, and that under such circumstances not only are there no symptoms of poisoning, but the health and strength and complexion are all improved. The chief evidence in relation to this subject (and the evidence appears to be unimpeachable) comes from the arsenic works of Styria and some parts of Austria. No doubt amongst arsenical workers cleanliness is of great importance; not improbably improvements in process of manufacture have been, and may be, made beneficial to the workpeople; but as a general rule those who are specially liable to suffer, and those whose exposure is only accidental, will do wisely to escape danger by its avoidance.

Chronic mercurial poisoning.—The per-salts of mercury, like all preparations of arsenic, are very potent irritant poisons. And all salts of mercury, after having been taken for a longer or shorter time, produce characteristic effects, the most prominent of which are salivation, swelling and tender-

ness of the gums, loosening of the teeth, and fœtor of breath, in association with more or less cachexia, and disturbance of the digestive organs. Further, ulceration and gangrene of the parts about the mouth are apt to ensue. But chronic poisoning occurs among the workpeople who are habitually exposed to the vapour or dust of mercury, or its salts, especially, therefore, amongst those employed in quicksilver mining, water-gilders, the manufacturers of looking-glasses, barometers and thermometers, furriers and persons engaged in the packing of furs, which have been brushed over with solution of nitrate of mercury. Yet, curiously, although such persons may present the symptoms commonly observed in patients who have been subjected to mercurial treatment, for the most part their symptoms are of quite a different character, being of a paralytic nature, and referable to the nervous and muscular systems. The condition is, in fact, known by the name of metallic, or mercurial, tremor. The first signs of its presence are :—a general tremulousness of the hands and arms, which comes on gradually; numbness, and tingling in the hands and feet; and occasional pains in some of the joints. Such symptoms are common amongst workpeople exposed to the vapour of mercury, and may continue for years without materially interfering with their capacity for work or their general health. But, sooner or later, they tend to get aggravated; they not only become more violent, but gradually extend to all parts of the muscular system, so as to involve at length hands, arms, legs, head and neck (including the muscles of expression, speech, and swallowing), and trunk, with the muscles of respiration. Then the violent trembling of the hands and arms renders the sufferer incapable of using these organs; he cannot lift a glass of water to his lips, or feed or dress himself; the agitation of his legs becomes so great that he is unable to walk without being supported on either side; the convulsive action of the muscles of the head and neck causes constant tremulous movements of these parts, while that of the muscles of expression reveals itself in grimaces, and that of the

lips, tongue, and muscles of mastication causes tremulous and indistinct utterance, and difficulty in chewing; the involvment of the respiratory muscles induces dyspnœa. These convulsive movements are generally absent when the patient is making no muscular effort; but sooner or later they do not wholly cease even when the patient is in bed or asleep. And at length, possibly, as in the later periods of lead palsy, vertigo, headache, loss of memory, delirium, epilepsy, or distinct paralysis comes on. It is remarkable that the symptoms above enumerated are by no means necessarily associated with other indications of mercurial poisoning, or signs of ill-health. But such symptoms sometimes attend the onset of the palsy, or arise during its progress; and probably always towards the end the patient gets sallow, emaciated and weak, loses appetite, and presents a general failure in his corporeal functions.

In order to prevent the occurrence of mercurial tremor the same rules with respect to ventilation and cleanliness as have been laid down for workers in lead should, of course, be followed. It is probable, too, that in some of the occupations which entail exposure modification of process might be advantageously introduced. But it is quite certain that all persons who are habitually exposed, as some of the workers must be, to mercurial fumes, are liable to suffer. Fortunately for them, if they be treated early, and especially if they give up their dangerous occupations, a cure is probably always possible.

Chronic phosphorus poisoning.—Shortly after the introduction of phosphorus in the manufacture of matches, it began to be observed that a peculiar affection of the jaw was apt to come on in those who were engaged in the match factories. The first person to call attention to the subject was Dr. F. W. Lorinser, of Vienna, who in 1845 published an account of twenty-two cases of jaw disease, of which the earliest had occurred as far back as 1839. In 1847 Drs. Von Bibra and Geist published jointly an elabo-

rate work on the subject, in which they gave an analysis of sixty-eight cases, which up to that time had occurred in Germany. During the next few years many cases of the disease were recorded in England, France, and other countries, and several works on the subject were published. And in the year 1862 it fell to my lot to make, for the Medical Officer of the Privy Council, an exhaustive report on the subject, so far as it related to the phosphorus industry in England. I ascertained at that time that at least sixty-one cases of the disease had happened in this country; and that, without exception, all the cases had occurred amongst the operatives in match factories.

The disease consists in a slowly progressive inflammation of the periosteum of the under or upper jaw, or both, resulting sooner or later in the necrosis or death of the bone, which ultimately (if the patient survive so long) is thrown off, or comes away. The patient, in fact, loses the whole, or a part, of the upper or lower jaw, as the case may be; and, besides incurring all the distress and danger which attend a long-continued, foul, and enfeebling disease, emerges from his malady permanently, and often hideously deformed. I quote the following account of the affection from my report just referred to:—"The disease, it was noticed, began usually with aching in one of the teeth. At first this was probably mistaken for an ordinary toothache, and would indeed at times intermit. Sooner or later, however, recurrence of pain necessitated the extraction of the tooth, and the pain and annoyance for a time probably ceased. The wound in the gum, however, was found not to heal; offensive matter began to ooze from it, and ere long a portion of the alveolus became exposed. Occasionally the portion of bone thus denuded came away, bringing with it, perhaps, one or two of the neighbouring teeth, and the disease made no further progress. More frequently, however, the disease continued to spread, and, sometimes slowly, sometimes rapidly, more and more of the jaw-bone became denuded; the gums grew spongy and retreated from the alveoli, the teeth got loose and fell out,

the fœtid suppuration became more and more copious, the soft parts around grew swollen, tender and infiltrated, and often the seat of sinuses. And thus the disease continued to progress, till in the course of six months, a year, two years—it might be even five or six years—the patient sank from debility, or from phthisis, or from some other consequence of the local affection; or, having lost piecemeal, or in the mass, large portions, one-half, or even the whole, of the upper or lower jaw, returned to his original state of good health, but the victim of a shocking and permanent deformity. During the earlier and more acute stages of the disease, constitutional disturbance, as might be expected, generally showed itself, indicated by febrile symptoms, loss of appetite, thirst, constipation, a sallow, pasty condition of the skin, and these were often associated with intense pain in the affected parts, and consequent sleeplessness. After a while, however (especially in cases that were tending to a favourable issue), pain and constitutional symptoms diminished, and the patient sometimes recovered the aspect of health, even while necrosis of the jaw was still progressing."

The disease occurred only amongst such as were largely exposed to the fumes of phosphorus, and was generally confined to those whose duty it was to dip the matches in the melted phosphorus paste. Occasionally, however, in crowded and ill-ventilated factories, others besides dippers were affected. It was clear, (although that point has been disputed, and was not originally held) that the disease was due to the local influence of the phosphorus fumes, and not to constitutional contamination; for there was no evidence whatever that persons exposed suffered in the slightest degree in their general health; and indeed the subjects of the phosphorus necrosis were always in good bodily health, until they began to suffer from the injurious effects of their local malady. It was thought by many that the disease only attacked those who had decayed teeth; and that the phosphorus exerted its immediate influence upon them. This view, however, was not entirely confirmed

by observation. It seems, indeed, that, though the malady affected in largest proportion those with carious teeth, the special condition which made persons liable to attack was soreness or ulceration of gum, no matter how produced.

In speaking of phosphorus necrosis, I have spoken mainly in the past tense, because, although not improbably it even now prevails in some parts of the world, and especially in overcrowded, ill-ventilated factories in which the cheaper forms of matches are still manufactured, I believe that owing to the precautionary measures which have been adopted, and especially to the large use of the amorphous phosphorus, which yields no injurious vapour, the disease has largely, if not entirely, disappeared from among us. At any rate, very little has been heard about it for some years, and no case has come under my own observation.

Effects of irritants applied to the skin.—From the group of affections just considered, due to the poisonous action of certain mineral substances, to which in various industrial processes workmen become exposed, I pass on to give a brief consideration to the direct irritating influence on the skin of certain matters which are generally regarded as inert, and in fact generally are inert. It is well known that grocers, bakers, washerwomen, and others, are liable to inflammatory affections of the skin, mainly and primarily of the hands, commonly known as grocer's itch, baker's itch, washerwomen's itch, and so on. These affections are not itch in the proper acceptation of the term, but eczema, or a variety of eczema, induced and kept up by the irritant effects in the first case of sugar, in the second of flour, and in the last of soap, or rather of imperfectly made soap or of the soda which is so constantly employed in washing. Most persons are acquainted with the fact that some delicate and irritable skins are readily irritated and inflamed by even the purest soaps. Common soaps, in which alkali is in excess, or the ingredients are insufficiently mixed, are injurious to most skins. It is a phenomenon of the same kind which washerwomen at times present; but

the simple irritation of the skin tends to become, in consequence of the constant use of soap and soda, a veritable inflammation of the skin, and before long results in vesication and excoriation. The above eruptions, which present little difference among themselves, are of course readily cured by the avoidance of the conditions to which they are due.

In relation with this subject I may briefly refer to two other kinds of skin disease which are determined by occupation, the one the so-called "*chimney-sweeper's cancer*," the other a somewhat analogous disease, sometimes termed, though inappropriately termed, *verruca necrogenica*, or, if one may translate the name into English, *the dissector's wart.*

In former days, when chimney-sweepers used to go up chimneys, and their occupation led to their being constantly begrimed with soot, it was observed that they not infrequently became the subjects of a form of cancer of the skin now commonly known as epithelial cancer or epithelioma. This disease is not special to chimney-sweepers, but in them it affected parts of the body which are not usually attacked in other persons; and the relative frequency with which it was observed in them acquired for it from the distinguished surgeons who first observed it the distinctive name which we have quoted. I believe that what was called chimney-sweeper's cancer is very rarely met with now, and that its infrequency is due to the practical discontinuance of the conditions which were believed to engender it.

The dissector's wart is special to persons whose hands are constantly employed in the dissection or cutting up of dead bodies. Hence it is common among persons engaged in pathological researches, in those who frequent dissecting-rooms, and I believe also it is met with among butchers and knackers. It is a curious kind of circumscribed thickening of the knuckles, associated with the formation of pits or excavations, and the accumulation of crusts or scabs on the surface. The affection slowly spreads, and, so far as I

know, never dies out, unless either it be destroyed by strong caustic applications, or the sufferer renounce the duties which first excited it.

Effects of irritants applied to the lungs.—But the irritant effects of matters which are not poisonous are not limited to the skin. Occupations which habitually expose the workmen to the inhalation of abundant solid particles, that are incapable of solution or removal by the animal tissues or secretions, in many cases induce chronic diseases of the lungs, which are known as the asthmas or consumptions of the several occupations referred to, and tend very materially to shorten life among those engaged in them. Workers in coal-mines and in copper-mines, grinders, millstone makers, and flax-dressers are perhaps especially liable to suffer from such causes. It is marvellous how tolerant the bronchial tubes and lungs are of foreign particles which are drawn into them with the breath. Wherever smoke impregnates the atmosphere, as in London and other manufacturing towns, its particles are conveyed in greater or less abundance into the lungs; whence some are expelled with the expectoration, which presents, consequently, a slaty or black appearance, while some get absorbed, and, becoming deposited in the tissues of the lungs, produce in them that black mottling which increases with advancing years, and is well known to pathologists. Yet, as a general rule, the soot-studded organs remain practically healthy, and no clinical evidences of pulmonary disease manifest themselves. The same remarks doubtless apply to the inhalation of the silicious particles of ordinary dust. The effects are different, however, when such matters are inhaled in large excess. In coal-miners the lungs occasionally become almost as black as coal; and the excessive accumulation of carbonaceous matter induces a chronic inflammatory condition of the organs, associated with induration, and occasionally with the breaking down of the pulmonary texture. Among copper-miners something of the same kind occurs; but in this case the sooty matter is associated

with a large proportion of silicious particles, which are far more irritating than simple carbon, and more rapidly induce chronic inflammatory changes than it. In grinders and mill-stone makers, the inhaled particles are mainly stony or silicious particles, and the injurious effects ensue with greater rapidity. Among flax-dressers the pulmonary mischief is of the same kind. It appears, indeed, that the particles which are absorbed exert no specific influence; that whether they be carbonaceous, silicious, or of any other nature, their effects are simply irritative, and to produce chronic inflammation or fibroid change; and that the only appreciable distinctive characters are such as are due to the quality of the particles imbedded in the lungs, and to the greater or less rapidity of progress of the disease. The symptoms under which the sufferers labour have some resemblance to those of chronic phthisis, some to those of chronic bronchitis and emphysema, for either of which they may well be mistaken. They consist in gradually increasing shortness of breath, lividity of surface, feebleness of circulation, and cough, with more or less abundant expectoration; to which, at a later period, general dropsy and hæmoptysis may be superadded. There is generally a total, or almost total, absence of fever. The only methods, so far as I know, by which the irritative diseases of the lungs just considered can be lessened or prevented, are by providing good ventilation, and (when possible) by adopting methods to prevent the diffusion of particles or dust in the atmosphere which the workmen have to breathe. It is obvious, too, that since the diseases are insidious in their progress, and increase in proportion as the inhaled particles accumulate, it would be well for persons who present early traces of them to seek at once some other kind of employment. Much of our knowledge of the subject just considered is due to the labours of Dr. Headlam Greenhow.

Phthisis in connection with sedentary work and defective ventilation.—But, quite apart from the inhalation of solid particles which irritate the lungs into disease, it is certain

that many occupations tend to the production of pulmonary phthisis and fatal bronchial affections. I will quote the remarks made by Mr. Simon, in reference to information which his inspectors had obtained concerning the lives of straw-plaiters, lace-makers and glovers at Berkhampstead, Tring, Towcester, Newport Pagnell, Nottingham, Radford, Barford and Yeovil; the lives of watch-makers at Coventry; the lives of button-makers, jewellers, and various knick-knack makers at Birmingham and Sheffield; the lives of stocking-makers at Lincoln, Nottingham, Radford, Basford and Hinckley; the lives of pottery artisans, especially of the decorators of earthenware, at Stoke and Wolstanton; and the lives of factory operatives employed on cotton, silk, flax, and wool at Preston, Leeds, Bradford, Pateley Bridge, Macclesfield, Leek, Stroud, Melksham, Coventry, and Blackburn. "The concurrent testimony," he says, "of these most various illustrations is—that commonly, where many persons are employed together at any indoor industry, the ventilation of the work-place is likely to be so bad as to convert the employment, which perhaps is not in its own nature of hurtful tendency, into an employment seriously dangerous to health. Here lies the explanation of a fact most deplorable for the working classes of our country—that, *in proportion as the people of a district are attracted to any collective indoor occupation, in such proportion, other things being equal, the district death-rate by lung-diseases will be increased.* For the bad ventilation which, as a rule, belongs to the place of employment, tends to develop among the workpeople a large excess of phthisis, and probably also some excess of other fatal lung disease." It was further proved, by evidence obtained by Dr. Edward Smith in reference to printers and tailors, and by Dr. Ord in reference to dressmakers, and published in the appendix to the report from which I have been quoting, that the mortality from pulmonary diseases was also very high among them. Dressmakers appeared to suffer least; but printers, and above all tailors, whose hours of work were much prolonged, and whose work was largely conducted in over-crowded, ill-

ventilated apartments or workshops, suffered severely. The document from which I quote appeared just twenty years ago. It is probable that in many cases much sanitary improvement has taken place since then.

Spread of infectious fevers in connection with certain industries.—There are a few occupations which render those who carry them on liable to contract infectious diseases accidentally brought to them by what are technically termed *fomites*, that is, by articles which have become impregnated with, or contaminated by, the virus or poison of the diseases in question.

Seeing how virulent the contagia of most infectious diseases are; how they cling to clothing, to wall-papers, to filth, and even to most things brought into relation with them whose surfaces are porous or rough; how such diseases are apt to be conveyed by healthy persons passing between the sick and those who are susceptible, by the transmission of articles of apparel, by books, by letters, by milk, and other articles of food, and in many ways, some of which are scarcely suspected; it seemed reasonable to believe that the spread of disease might be due in no inconsiderable degree to rags collected here, and imported, for the purposes of paper-making. In the year 1865, I made an extensive inquiry into the question of the spread of infectious diseases by rags, and more especially among the workpeople engaged in paper-making. The result was to a considerable extent reassuring; for it appeared in the first place that no diseases special to foreign countries had ever been introduced amongst them by the agency of foreign rags, and that as regards native rags the only disease that was ever spread by them was small-pox, and this only rarely. A recent inquiry by Dr. Parsons has, in the main, confirmed the conclusion at which I had arrived, but shows, I think, that small-pox is somewhat more frequently spread by rags than my own inquiries had led me to believe. There are many reasons for the comparative safety of the rag trade which I need not now discuss.

But the most interesting facts, in relation to the spread of infectious disease by the use of materials impregnated with morbific virus, are those which have been collected during the last few years, in reference to the affection known in Bradford as the "wool-sorters' disease." I may state at once that this has been ascertained to be the anthrax fever, or splenic fever of cattle—a very fatal bovine disease, which prevails in many parts of the Continent, and also in Asia and America, and is known to spread readily from cattle to other animals, and to man. Anthrax fever is one of the few diseases which have been clearly proved to depend on the entrance into the system, and the growth in it, of specific forms of living vegetable organisms, or bacteria; and it will, perhaps, be recollected that it is one of the affections the virus of which M. Pasteur claims to have attenuated, or rendered less virulent by cultivation, so that by inoculation of animals with the cultivated products a mild form of the disease is imparted which protects from future more virulent attacks. The disease has some resemblance to glanders in the fact that it commences sometimes as an external or superficial disorder, sometimes, like most other specific fevers, as an internal or constitutional complaint. In the former case an inflammatory swelling arises on some part of the surface exposed to the air, which is attended with much redness and brawniness of surface, and in the centre of which soon appears an area of gangrene, or sloughing. This affection is commonly known as malignant pustule. In some instances the disorder remains purely local, and recovery takes place with the subsidence of the local mischief. But not infrequently death ensues, either from constitutional disturbance due to the severity of the local inflammation, or with the usual symptoms of constitutional anthrax. The internal form of the disorder is the more common, and also the more fatal. Its period of incubation is uncertain. At its commencement the patient complains of feverishness, with weakness, chills, and usually perspirations. After a short time the symptoms become almost suddenly aggra-

vated ; the temperature rises, the pulse and the respirations become rapid, difficulty of breathing, with precordial anxiety, comes on, the surface gets cold and livid, and the patient falls into a condition of prostration or collapse. Sometimes there are signs of local congestions of the lungs, or of the abdominal organs, and hæmorrhages are not infrequent ; and very often delirium, coma, and even convulsions occur before the fatal termination. The disease is fatal in large proportion, and death usually ensues in the course of four or five days.

Now anthrax fever has never prevailed as an epizootic in this country, and British medical practitioners and veterinary surgeons have as a rule had no experience of it, and have hence been almost certain to overlook or to misinterpret isolated cases of it. In the year 1878, however, the attention of Dr. Russell, the medical officer of health for Glasgow, was called to a group of mysterious attacks of disease, attended with a high mortality, which occurred at a factory in that town, among workers in Siberian horsehair. He ascertained that this mysterious disease was anthrax fever, and concluded that the workmen had contracted it from handling affected horsehair. Two years later the attention of the Local Government Board was directed to the existence at Bradford of a disease frequently fatal, but only imperfectly understood ; and Mr. Spear was directed to inquire into the subject. The following quotation from Dr. Buchanan's Report for the year 1880 summarises the results then arrived at : " Mr. Spear found that, in sequence to a large number of occasional cases, the nature of which had at the time of their occurrence been matter of suspicion, some thirty or forty cases, definable as anthrax, had occurred in eleven months among woolsorters in Bradford and neighbouring districts, and that no less than twenty deaths had to be ascribed to this cause. The disease, whether it shewed itself more by external or internal symptoms in the persons of the affected wool-sorters, was found by pathological observation to be uniformly characterised by the presence of bacillus anthracis

in the blood and organs; and the material of the disease had been received, it appeared, into the body of the worker, now by the way of the skin, now through the lungs or stomach. Experiments conducted by Dr. Greenfield, in aid of Mr. Spear's inquiry, showed that in all cases where decomposition did not interfere with the result, the fluids derived from fatal cases of the disease were capable of producing the same disease in mice and guinea-pigs into which those fluids were inoculated. An unintentional experiment on cows and sheep was made by the irrigation of certain fields with the washings of wool from a factory near Keighley, with the result of producing unexpected deaths among the animals pasturing on the fields; their disease having characters similar to those observed in the human subject, particularly in the presence of the same bacillus anthracis in the fluids of the body."

"Not all wools and hairs were found equally capable of producing the disease. The dangerous wools were foreign wools, and the most dangerous of all was a kind of mohair coming from the Van district of Armenia. There appeared reason, moreover, for believing that the infective quality resided more especially in the 'fallen fleeces' of a wool-bale; in that portion, namely, of the wool which had been shorn from dead animals, and which forms about five per cent. of the whole."

In the report of the Local Government Board for 1882 are comprised the results of a further inquiry by Mr. Spear with respect to the occurrence of the same disease among persons engaged in the London hide and skin trades. It would take too long to consider the details of this very interesting report. But it shows conclusively that anthrax fever, in both its forms, is of not infrequent occurrence amongst those concerned in the industries referred to; and that, as might be supposed, the chief sufferers are the persons who have to handle the raw hides coming from abroad, namely, wharf-labourers, sorters' labourers, and tanners' labourers. No evidence of the occurrence of the disease could be traced amongst fellmongers. It is an

interesting fact, too, as further proof (if need were) of the nature of the disease amongst the workmen in London, and of its virulence, that in consequence of the removal from a tannery, in which there had been special recent prevalence of anthrax, of refuse for manurial purposes to a farm near Guildford, a destructive outbreak of anthrax occurred among the farm horses and cattle, just as had occurred previously in connection with the Bradford epidemic. These several inquiries show conclusively that the workmen who have to do with foreign hairs and hides incur a serious risk of contracting anthrax. There can be no doubt that many such attacks have been overlooked up to the present time, and it is satisfactory to know that now at length the danger is generally appreciated, and that precautionary measures against it are generally adopted.

There are still two or three diseases which may, I think, be fairly called industrial diseases, to which, before I conclude, I should like to advert: one is the so-called "clergyman's throat," another is the affection known as "writer's cramp," or scrivener's palsy. Clergyman's throat is not limited to members of the clerical profession; but is an affection to which all habitual or professional speakers and singers are liable. It is a form of follicular laryngitis, which is caused by the constant over-exertion of the voice, especially if that over-exertion be continued at times when the patient is suffering from catarrh, and which, if the over-exertion be continued, is apt to become chronic and incurable and to incapacitate the sufferer from his duties. Scrivener's palsy is a peculiar affection to which clerks and persons who have to do much writing are liable. It consists in a kind of momentary loss of power or spasm, which affects the muscles of the thumb and fingers engaged in writing, which in advanced cases involves the muscles of the arm as well, and which either causes the writer to drop his pen, or to make some sudden movement that checks or mars his writing. In a large number of cases the disease is progressive, and finally renders continuous writing wholly

impossible. Sometimes its development in one hand has compelled the sufferer to learn to write with the other hand. Unfortunately for him, however, the affection is apt to spread from one side to the other. Scrivener's palsy is only the best-known, and perhaps the commonest, of a group of spasmodic or paralytic affections to which persons who have acquired skill in the use of particular groups of muscles are liable. The pianist, the swordsman, and others whom it is needless to enumerate, suffer from analogous disorders.

The sketch of industrial diseases which I have given is short and necessarily incomplete. I cannot pretend that I have consulted all the literature on the subject which has accumulated during the last few years; and my personal studies are limited to two or three inquiries which I conducted many years ago for the medical officer of the Privy Council, and to the casual material which has been afforded me by my position as an officer of health and physician to a large hospital. It is probable, therefore, that there are some well-known industrial diseases with which I have no acquaintance; and, with respect to some of those which I have brought under your notice, I cannot speak with any certainty as to what their present prevalence is as compared with their prevalence years ago. Moreover, I have not ventured to enter at any length on the important question of their prevention. I console myself, however, with the consideration that it would have been utterly impossible for me, even if my knowledge of the subject had been profound, to give an adequate account of industrial diseases in the limited time placed at my disposal; and that my paper will be completed and corrected by the observations it will doubtless elicit from those whose knowledge, of at any rate particular parts of the subject, is much more intimate and much more recent than mine.

DISCUSSION.

Dr. William Ogle said that the preceding speakers had discussed the question from a medical point of view, but he would ask to be allowed to approach it from the statistical side, because of late he had been occupied officially in examining at great length, and at great expenditure of time, into the mortality of different trades and industries, and to a certain extent into the causes of such mortality. The basis of the inquiry was in the first place the census of 1881, which gave the numbers engaged in each trade, and their ages, and the death registers for the years 1881, 1882, and 1883. It would be advantageous to discard altogether all recognition of the earlier periods of life up to twenty-five, and of the later periods of life after sixty-five, and therefore the remarks which he should make would refer to males between twenty-five and sixty-five, which, after all, was the time when professional or trade influence was most marked. As figures were extremely difficult to catch and to realise when following a speaker, he would try to simplify the matter by the device of speaking of the death-rate of males in England as being 1000, and should refer death-rates in all other trades to this as a standard, and instead of calling them "death-rates" he would call them "comparative mortality figures." He had in his hand the comparative mortality figures of some 80 different occupations, and the first thing which struck him was the enormous difference in these figures. There were some lucky occupations in which the comparative mortality figure was scarcely more than 500, and in others it was as much as 2000 or 2200, so that there were actually occupations in which an ordinary average person was four times as likely to die as if he were in some other occupation. It might be gratifying, perhaps, to those who wore the blue ribbon to know that the occupation at the head of his list was inn and hotel servants, the mortality figure for this occupation

being 2205; that is to say, their chance of dying was more than twice as great as that of an average man of the same age.

Almost next to this class came innkeepers, publicans, and wine and spirit merchants, with a mortality figure of 1525, and then brewers, with a mortality figure of 1361. These facts by themselves would justify one in concluding, *à priori*, without other evidence, that this high mortality was due to alcoholic excess, but he had taken out sufficient number of data from the death register to enable him to calculate, for certain occupations, the death-rate not only from all causes, but the death-rate from special diseases. Having looked to see to what disease it was that this enormous mortality among innkeepers was due, he found that the death-rate from liver disease was no less than seven times as high in that occupation as it was among males in general. He found, moreover, that the death-rate from brain diseases was twice as high among innkeepers as it was among ordinary men · and there could therefore be no doubt that the high rate of mortality of these three groups was due to alcohol. It was no wonder that Insurance Offices, though they already make a surcharge of ten per cent. upon the lives of publicans, should nevertheless find that this does not cover the risk. There was only one trade out of twelve, for which he had the necessary data, which in any way resembled the innkeeper, and that was the butcher. The mortality figure for butchers was 1176, and they also died in a large proportion from diseases of the brain and liver. Their death-rate from diseases of the nervous system was twice as high as that of men generally; and their mortality from liver disease was also far above the average, though by no means so high as that of innkeepers. Another group of occupations which also had excessively high death-rates, comprised those engaged in the traffic of streets and on canals. The comparative mortality figure of cabmen was 1482, of carters and carriers 1374, and bargemen, lightermen, and watermen 1305. Doubtlessly exposure

to wet and liability to accident were contributory causes to the high mortality in these occupations; in which, however, he could not but suspect that excessive indulgence in alcohol also played a considerable part.

He turned now to those numerous occupations in which the workman was exposed to the inhalation of much dust. The death-rate from lung diseases in cotton, silk and wool factories, was rather high, owing to the dust which was given off, though apart from this cause the general death-rate of persons employed in textile industries was not very high.

In the china and earthenware manufactures the comparative mortality figure was no less than 1742; in the glass manufacture, 1190; file-makers, 1667; among cutlers, 1309; stone and slate quarrymen, 1125. The diseases prevalent amongst operatives in earthenware factories were chiefly of the respiratory organs, and phthisis. The mortality from this class of diseases was almost three times as high in the earthenware industry as among males generally. The high mortality amongst file-makers was also due in great part to phthisis, bronchitis, pneumonia, and lung diseases, but besides this he found other diseases prevalent in this industry. Looking down the death-rates he found that the death-rate of file-makers from kidney diseases was no less than four times that of average men, and that the deaths from brain disease of various kinds were about 70 per cent. over the average. To what was this due? He had no doubt whatever that it was due to lead poisoning, for out of the deaths of file-makers, which formed the basis on which the calculation was made, numbering 280 in all, 7 were returned as dying from lead-poisoning. As all medical men knew, they could not measure the amount of lead poisoning and its fatal effects by the deaths that were directly ascribed to lead poisoning, but must also take into account the after-effects of lead, and these after-effects told upon the kidney and brain. If they took any trade where lead was used much, they found that the mortality from diseases of the brain and kidney

were greatly in excess. In order to see whether this was correct or not he had taken out the death-rates of another trade in which lead poisoning was common, namely that of painters, glaziers and plumbers. The mortality figure in this occupation was 1202; and he found that, taking away the diseases due to respiratory organs, the death-rates were almost identical with those of file-makers, showing a similar excess under kidney disease and brain disease, and there were no other trades which resembled them in this respect. He thought there could be no doubt whatever that they must add the file-makers to the class affected by chronic lead poisoning, though he found that trade omitted in the books dealing with lead poisoning. The mortality figure of cutlers was 1309, and they resembled the file-makers in having a great death-rate from disease of the lungs, though they had no similarly excessive death-rate from disease of the kidneys.

The death-rate of hair-dressers was enormously high, though why he did not know, the mortality figure being 1327. For furriers and skinners the figure was 1117, whilst for those who worked in hair and made brooms and brushes, it was not quite so high. If one could have the causes from which the hair-dressers died, it might be found that they had disease of the lungs from swallowing particles of hair and dust. Another occupation in which the mortality was very high was that of the law clerks, which, perhaps, was owing in part to habits of intemperance. Medical men and stone and slate quarriers were alike, so far as their mortality was concerned, the mortality figure for such being 1122. The death-rates of grocers and various kinds of shopkeepers was rather below the average, the figure for the grocers being 771.

Turning to the other end of the table the mortality figure for clergymen was only 556; gardeners 599; farmers, 631; and agricultural labourers, 675.

> "O! fortunati nimium, sua si bona norint
> Agricolæ!"

Dr. ORD said he would commence by thanking Dr.

Bristowe for his most admirable address, for he had put before them in a short time an enormous amount of valuable matter, compressed without losing its clearness, after a fashion which was acquired, no doubt, by many years' long experience in teaching and writing. It was a kind of paper which one got not very often, but which they obtained from men who had thought and read much, and taught a great deal. He was sorry to be called upon first to speak, inasmuch as his own acquaintance with diseases of an industrial kind had been limited so far as matter of inquiry was concerned to the small group to which Dr. Bristowe alluded in a few words, viz., the diseases affecting milliners and dressmakers. Twenty years ago, when he investigated these diseases, the conditions under which these persons worked were not such as now existed. He referred to the conditions affecting the personality of the person engaged, and also in one point of view the social condition. Thus there was an important element of imperfect pay, and consequently imperfect food. There were also elements of overcrowding in ill-ventilated, ill-lighted rooms, as well as the important element of long and protracted hours of work. These were obviously the things which legislation and inspection under legislation could modify, and he had every reason to believe that during the last few years the health of this group of industrial labourers had been improved. But seeing that there were ladies present he was emboldened to go into the subject of female industry, and to say a few words about the influences which bore disastrously upon the health of domestic servants. As was well known, there was "The Song of the Shirt," but there was an almost equally touching song of the scrubbing-brush and the door-step; of the weights to be carried upstairs; of the full pail, of the coal-scuttle, and of the weight of the body going up and down stairs many times a day. Dr. Sibson had drawn attention years ago to the existence of influences bearing upon our young population, which were akin to those to which he now wished to draw attention. Dr. Sibson, in dealing

with what was called acute rheumatism, showed that its victims were chiefly adolescents or young adults, who had been so exposed to particular influences as to make it practically certain that these influences were important proximate causes of the affection in them. He found the victims were most commonly adolescents and young adults, who had either been using extreme muscular exertion, in excess of their natural strength, or working long hours in close rooms, ill-ventilated, and particularly ill-lighted. His paper on the subject proved the case very clearly indeed, and brought out these points as the main features explaining the remarkably frequent occurrence of this disease among young people at such ages. Conditions of this kind largely affected domestic servants. At the present time houses were cramped together so closely that every square foot of ground was of value, and domestic servants passed a large portion of their life practically underground, very often in damp rooms and in a small quantity of light and pure air. Here was the first of Dr. Sibson's conditions fulfilled. Add to this the constant muscular strain involved in stair climbing with heavy weights, and the second condition was fulfilled. Among this class there was a great deal of rheumatic fever, and its terrible consequences known to physicians, such as disease of the heart and the other ailments which tended greatly to shorten life. He had not come there to suggest remedies, but merely to speak out once in his life what had filled him with regret very often, when going through the wards of the hospital, and seeing patients suffering from a disease which was in a sense preventible. He did not know that the whole matter could claim to be, at present, worthy of the title sometimes used—the title of the "social problem," but it was a matter for the deepest and saddest meditation.

Dr. GREENHOW said the subject was a very wide one, and Dr. Bristowe had given a very complete digest of the present state of knowledge upon the subject; but still he might perhaps be permitted to say how greatly he rejoiced

that the managers of the Health Exhibition had thought fit to include among the Conferences to be held there the subject of industrial diseases. There were a great many public health questions which were of great importance, of which persons had some knowledge; but the industrial disease question was one which had received very little public attention, although it was second to no other sanitary question of the day, because the sickness and mortality produced by these diseases was very large. It would be impossible to go into details respecting the other kinds of disease mentioned by Dr. Bristowe, but he would restrict his remarks to lung diseases, and quote two or three figures which would illustrate the question and show how large an influence those diseases had in producing premature death in Great Britain. In order to do this, he would take as his illustration two mining districts in the north of England, in both of which the inhabitants were exclusively miners and shopkeepers. One of the districts to which he referred was a coal-mining district, where the coal-mines were under the best possible superintendence, where every possible means were taken to preserve the ventilation of the mines, and to prevent the causes of disease to which Dr. Bristowe had referred. The figures which he should give had been worked out by himself many years ago, but still they were sufficiently near the point to show the general bearing of the question. The mortality amongst males from all causes in this district was 18 per thousand per annum on an average of seven years, and the mortality amongst females 17 per thousand for the same period. Taking the mortality from lung diseases among men above twenty years of age, when the effects of occupation would have told, he found it was only 3 in a thousand, and for females 2 in a thousand, but, he must repeat, that was in an exceptionally well-managed mining district. The other district to which he referred was in the same locality, about forty miles from the former, in which the occupation consisted in metal-mining. The mortality per thousand over the same period of time was 20 for men, and 17 for women, and

the latter fact seemed to show that both localities were very much the same as regarded their general salubrity; but when the mortality from lung diseases in the two districts were compared, a great difference would be at once observed. The mortality amongst men was 14 per thousand in the lead-mining district, and amongst females 7 per thousand. He had no hesitation in saying that this difference was due to the fact that the miners were exposed to special causes of lung disease. He thought it showed very clearly that he was justified in saying that these industrial diseases were amongst the most important sanitary questions of the day. And they were not confined to miners. Amongst the operatives in cotton factories, especially those engaged in the weaving-room, where China clay was used in sizing the cotton, and in the carding room; amongst potters, flax hacklers, grinders, needle-pointers, quarrymen, and also amongst miners in copper and tin, these diseases were very prevalent. If the public heard of a great colliery explosion, by which 100 lives were lost, they were struck with horror, the cause of the catastrophe was fully investigated, and usually funds to provide for the widows and children were collected; but he ventured to say that all the accidents and explosions in coal-mines fell far short of producing the mortality which was produced by the causes exciting lung diseases. If they had an epidemic of cholera in this country, which carried off 10,000 or 15,000 people in the course of a few months, the immediate attention of the legislature was drawn to the question; but the mortality produced by such epidemics was only occasional and for the most part occurred at distant intervals, and fell considerably short of the mortality which was every year incurred throughout the country at large by industrial diseases. That these diseases were caused by inhaling particles of flax, cotton, metal, and other dust was proved by the fact that these had been found in the lungs after death. It would be a mistake if he did not say that lung diseases were by no means confined to operatives in factories, or miners, or it appertained to a great many,

occupations of a small kind. In London there were numerous operatives who worked singly or two or three together, who were exposed to causes which would produce lung disease. Printers of colour suffered from lung disease by inhaling dust, and stainers of paper, corn meters, chaff cutters, and various other labourers suffered from inhaling dust in their various occupations. Moreover, lung diseases were very prevalent amongst people employed in large warehouses and shops, where the air was artificially warmed. The result of over-dried air was to bring on catarrh, and, as every one knew, there was nothing worse than a neglected cold, and this at length broke down the health of the person, and he died of an industrial disease. He hoped that the effect of this discussion would be to stir up public attention upon the matter. With regard to the prevention of these diseases he thought a great deal might be said, but it scarcely fell within their province to-day.

Dr. VACHER said it would appear that occupations were healthy or otherwise in proportion to the degree in which they permitted of the person occupied living under healthy conditions, and working under healthy conditions, and making use of his faculties. So they were in the habit of regarding clergymen and literary men living in the country as exceptionally good lives. Perhaps next to these merchants and business men, who live away from their work, and professional men where their professions do not place them in positions of exceptional risk. The working classes they found naturally divided under two groups, the skilled and unskilled workers who worked in the open air, and the skilled and unskilled workers who worked in shops. The first were as a rule healthy, but in different degrees, as between the cultivators of the earth on the one hand and scavengers and dustmen on the other. Those who worked in shops were as a rule unhealthy, but again in different degrees, depending on the work being active or sedentary, the workshop being well ventilated, or close, or draughty, or superheated, and the workers being exposed to noxious gases, fluids, and dust.

Among those who worked in shops they found a certain class of them, where the work was very sedentary, who appeared to have a curious instinctive dislike to ventilation. He had noticed this particularly among tailors and shoemakers. These people loved a high temperature, were very sensitive to the least motion of air, and often, in spite of the efforts of their employers, persisted in breathing over and over again air charged with carbonic acid and aqueous humour as the result of the respiration of themselves and their fellow-workers. Along with this class he might also group dressmakers and milliners, and some clerks and factory workers—indeed, all who worked in shops the air of which was rendered impure only by the exhalations of the lungs, and it was to be noticed also that all such workers affected a stooping posture. They suffered from diseases of the respiratory and digestive organs. What should be done in the case of the class to which he had just referred, was to ventilate the air of the workshops automatically, so that the people could not interfere with it, and also to instruct them to adopt an attitude which would give full play to their lungs. The second group of unhealthy trades were formed by those in which noxious vapours and gases were generated, principally by chemical decomposition. These works were alkali works, ammonia works, artificial manure works, bleaching-powder works, iron furnaces, galvanising works, and also copper works. He knew one copper-refining works in his district where, besides sulphurous acid, arsenical fumes were given off. Some time ago he was engaged in an inquiry upon the effect on health of the noxious vapours given off by chemical works, and he then found that the offending works were those he had stated. The noxious vapours were sulphurous acid (largely in excess of all others), hydrochloric acid, ammonia, chlorine, carbonic oxide, and, to some extent, zinc fumes and arsenical fumes. There was abundant evidence that chemical noxious vapours produced and aggravated diseases such as bronchitis, asthma, pneumonia, and phthisis ; in certain works also sick head-

ache, loss of appetite and indigestion were produced. What was wanted to render the trades healthy was the adoption by manufacturers of the most approved scientific processes. Chloride of lime, for instance, was still commonly made in the old wasteful dangerous way: lime was spread over the floor of a large room into which chlorine was delivered, and the lime was permitted to absorb as much as it would and then the doors were thrown open and the chlorine allowed to escape, rendering noxious the external air. Of course, it acted prejudicially upon the men employed to open the doors. The acid liquor in the chlorine generators was turned into the river, and in all towns where there were alkali works, the rain, after percolating through the waste heaps, which contained sulphide of calcium in considerable quantities, went into the river and so polluted the water by the setting free of sulphuretted hydrogen. Yet neighbouring works used Weldon's process, where all the chlorine which was made was conserved, and the manganese regenerated and no waste turned into the river. It might be thought that the Alkali Acts had done a great deal to improve the health of the inhabitants in the districts where the alkali works were situated, and this was so to a certain extent. Indeed, the Alkali Acts seemed to have been directed rather towards improving the general health of the district than to improving the health of the workers in the various works. The main result of the Alkali Acts had been to diminish the output of sulphurous acid, and doubtless this was a good work as far as it went, but still if the manufacturers used the best processes there was no reason to suppose that the health of the men would be to any great extent seriously prejudiced. Besides this, working men themselves who lived close to the works in a tainted atmosphere might do a great deal for the conservation of their own health if they made use of the chemically charged flannel screens for purifying the air in their cottages, as suggested many years ago. The third class of dangerous trades was the class which was rendered dangerous because

the workpeople were subjected to dust of one kind or another, and they had already heard a good deal about this from previous speakers. In his own district the classes specially liable to disease from dust were millers, bakers, masons, and coal-whippers. Here again it would be very easy to diminish the danger if all the works were obliged to efficiently ventilate their premises. Mr. Simon had stated that, with a single exception, the 300,000 miners in England break down as a class prematurely from bronchitis and pneumonia, caused by the atmosphere in which they live, the exception being the colliers of Durham and Northumberland, where the mines are properly ventilated. In some very exceptional cases it might be necessary to use a respirator of some kind; but either by the use of a fan or a respirator all the dust, from whatever cause occasioned, might be driven or filtered off. Besides these three classes of trades which were injurious to health, he might just refer to one or two others. It had been said that butchers were prejudicially affected, inasmuch as they worked amongst meat which might be diseased, that is to say, they might get inoculated with anthrax like wool-sorters. In his district they slaughtered sometimes as many as 600 head of oxen in the twenty-four hours, but he had never known a single case of a butcher having anthrax, though occasionally they dressed carcases which had to be condemned for anthrax. Then it was said that people who cleaned out the sewers were especially liable to typhoid fever; but in his district they unfortunately had sewers of deposit, and a gang of men were constantly employed to clean them out, and he had only known of one case of typhoid fever among this gang. As to lead-poisoning, his experience was the same as other speakers, for a year never passed that did not bring him cases of more or less pronounced lead-poisoning; and here again he believed that if proper precautions, as suggested in Government Blue Books, were taken, the cases would be fewer and less serious. Some time ago there was a factory for making a powder called Bradbury's Sheep-dip, which

was used in washing sheep to destroy parasites; and having examined this, he found upwards of three-fourths of the whole weight was sulphide of arsenic, and that the workers were never able to continue their work for longer than a month. They suffered from sores round the mouth and eyes, but no doubt this was due to the badly ventilated state of the works, and because they did not use soap and water as they were told to do. Indeed, the whole result of his experience and inquiries was to teach him that if known preventive measures were used by the work-people and by the employers, special trade diseases would all be much mitigated, and the greater part of them entirely repressed.

Dr. DIXON said with regard to lead-poisoning the symptoms were very often obscure, one of the most general being slight muscular pains in various parts of the body. As to the frequency of what were called septic diseases amongst tanners and persons employed in handling skins, he might say that for the last seven years he had been Medical Officer of Health for Bermondsey, and some short time ago he took the trouble of examining the old records of mortality to see whether there was any excess of diseases of this class, and he found the proportion of deaths from these causes was below the average for all London. All the cases which he had ever come across had arisen from inoculation from foreign hides, the disease being more common amongst labourers than amongst the hide-workers themselves. The butchers had a high rate of mortality, but it did not arise from handling animal matter, but from drinking drams of spirits. Unfortunately butchers were in the habit of treating, and he had not the slightest doubt that their high mortality table was due in a great measure to this. He knew an old butcher who was very well off in the world, who was always ready to have his glass of gin with a friend, but he had entered into a little conspiracy with the landlady of the house, to give him a glass of water instead of gin, and the result of this was that he main-

tained very good health, notwithstanding that he was a butcher.

Mr. LIGGINS said he should not have troubled the meeting with any remarks, had it not been for the fact that one class had been entirely omitted, namely, seamen. His experience proved that more sailors died from chest diseases which might be prevented than from any other cause whatever, drowning included. Sailors shipped in London frequently died before they reached Gravesend or the Downs, owing to exposure to the weather, and wearing improper clothing. He regretted to see the improvident fashion—for fashion was the proper word to use—which sailors adopted. The folly of not protecting the chest caused a great number of deaths amongst seamen, and the Conference would do well to take notice of his suggestion that the Royal Navy should start a fashion which would have a tendency to prolong their lives. Fishermen and yachtsmen covered their chests with thick jerseys, and, as a consequence, lived to a good old age. Upon one occasion when he was on a Royal Mail boat, the sea was so heavy as to require two quartermasters to steer the ship, and, notwithstanding that the sea was washing all over them, they had next to no clothing on: therefore, it was not to be wondered at that men in such positions as these had but short lives.

The CHAIRMAN said it was now his duty to offer some observations on the course of the discussion. With regard to what had been said by the last speaker, he would observe that the death-rate in the Royal Navy, which was under some sanitary inspection, was about $4\frac{1}{2}$ per thousand, whereas in the mercantile marine it was 18 per thousand, that excessive mortality arising from default of supervision, and under preventible conditions, which produced scurvy and a great deal of disease which was banished from the Royal Navy. The original registration measure was solely for the relief of dissenters from the necessity of registering their marriages, births, and deaths in the church. He had interposed, and got amendments introduced in the Lords, placing it on

a general footing and providing for the registration of the causes as well as the fact of death. He afterwards succeeded in getting Dr. Farr appointed to watch and expound the progress of the causes of death. It was pleasant to observe, from the paper of Dr. Ogle, that the function of the observation of the progress of the causes of death was not likely to fall through in his hands. He did not think attention had yet been properly drawn to the preventive action which had been provided, but which was neglected by public administration. He was one of the commissioners appointed to inquire into the labour of young persons in factories. They decided that public inspection was necessary, and their intention was that the inspection should be regular sanitary inspection, but it was not. It was also recommended that workshops should be visited by the officers of health at regular periods, the object being that by repeated and regular visits the officer of health would be aware of the occurrence of any premonitory symptoms of disease, and that it would then be his duty to separate the person affected, to go to his home, and ascertain if there were any causes there which produced the disease, and if so to take action for their removal. That again was a function which had been omitted, and also the regular inspection of schools for the detection of the premonitory symptoms of disease, and arrangements for following the children to their homes; and where it seemed likely to occur from causes which were removable, to take action for their removal. That was a function which ought to be provided for, but for various causes, including the neglect of changing political chiefs, that also had fallen through. Another proposal was that the cause as well as the fact of death should be certified on view of the body by a medical officer of health before interment. By that means a great deal of knowledge as to the preventible causes of death would be obtained for the direction of more efficient action and a larger gain of sanitary economy than was yet understood or thought of. With respect to the diseases occurring in particular trades, inspec-

tion had already stopped a great deal, and would certainly prevent an enormous deal more. Many manufacturers, when they put up manufactories, had every wish to construct them so that the workers might not suffer, but they wanted advice and approbation of their plans. Ventilation, or any other necessary sanitary condition, should be specified by a public officer, and in the majority of cases they would be adopted voluntarily. At Sheffield, he remembered, amongst the knife-grinders simple methods of prevention were pointed out, and he got Dr. Calvert and other medical men to assist, but the men would not adopt them; they had the idea that if those methods were used, and the death-rate were lowered, wages would be lowered also, and they preferred high wages with an excessive death-rate to the proposed amendments with the mistaken view of a reduction of wages. With respect to the diseases from dusty trades, they might be easily prevented. One means was regular head-to-foot washing and keeping the skin clean. Men who went in the thick of disease protected themselves in a way that he was afraid medical men did not invariably do, by head-to-foot washing twice a day; and if he had his time to go over again as an officer in an executive department he should issue a proclamation almost immediately, on the breaking out of any epidemic disease, that care should be taken everywhere to secure the thorough washing and cleansing of every one, especially children; for there was no doubt at all that the cleansing of children was an important factor of one-third in stopping the spread of disease. They were finding it out in Holland and other places abroad, where they were very careful that no children should come into school who were not thoroughly washed. If a child showed symptoms of uneasiness, it was taken out into a room, and some one attended to it, and if it was repeated fault was found with the mother. That was found to work capitally. They had the case of a death-rate in a school of 12 per thousand. The first step in sanitation was to clear the air from sewer-gas and smell, and it brought the rate down to 8 per thousand. The next factor was

having the children regularly cleansed in tepid water, and the death-rate was then brought down to 4 per thousand. By those two means of purifying the air and cleansing the skin the result was produced. There was an invention, which he was sorry was not shown in the Exhibition, recently introduced into the French army, whereby the captain was able to wash all his men for about 1–10th of a penny per diem. If that were generally adopted there would be a great saving in rations, for he had known of a case where an officer was hemmed in with a force in Spain and was obliged to put his men on half rations, but owing to their frequently washing in the river they really were as strong as men elsewhere on full rations. The invention he referred to was simply this: the men stepped into a tray of tepid water and a two-handled pump was worked to throw a jet of tepid water upon them, and they were cleansed in 5 gallons of water instead of 80 gallons of the bath, and in 5 minutes as against 20 minutes by the ordinary bath. The great importance of organisation and the prevention of disease had been clearly shown, but it had been neglected, and was not pressed in Parliament as it ought to be, but he hoped that the Conference would end in some practical action in that direction being taken. It was only by administrative means for the application of preventive science that the prevention of disease could be properly carried out. It must also be remembered that all that meant the prevention of a great deal of waste. A man might object to use this, that, or the other method, but he must not be allowed to charge other people with the consequence—to charge the poor rates or voluntary charity with the heavy expense of the default. The fact was that a portion only of the cost of preventible disease was generally taken into account; it amounted to a tax of three times the amount of the poor rates, which could not be less, and he believed was much more, than twenty-five millions a-year in England and Wales.

Dr. ALFRED CARPENTER then proposed a vote of thanks

to Mr. Chadwick for presiding. They of course regretted not to have the presence of the Duke of Northumberland, but it was a great privilege to see such a veteran sanitary reformer presiding, and himself showing what the study of sanitary science could do. They had had reference there and elsewhere to the fact that, before Dr. Farr occupied his position in the office of the Registrar-General, Mr. Chadwick was a well-known sanitary authority in this country, and was pressing on the attention of the Government the necessity for such an officer being appointed, and they had now had the advantage of hearing from Dr. Ogle, Dr. Farr's successor, some very important statistical facts which could not be too deeply impressed on the minds of the people of this country. The subjects brought forward to-day had been of the greatest importance, and he hoped that both the papers and the remarks of other gentlemen would be embodied in a report of the transactions, which would help to spread a knowledge of the important matters connected with industrial diseases. The Chairman had suggested that there should be an arrangement by which people could be washed at so much per dozen. He had heard that something of the kind was done in America with regard to children, and there might perhaps be places established in different parts of London where that could be carried out, but he was not prepared to suggest the absolute wisdom of such a course.

The vote of thanks was carried unanimously, and the Conference adjourned.

Conference on Thursday, June 12, 1884.

1. "*How Infectious Diseases are Spread.*" By W. H. Corfield, M.A., M.D.

2. "*On Cows' Milk as a Vehicle of Infectious and Epidemic Disease to the Community, with Suggestions for the more Effectual Prevention of such Outbreaks.*" By W. N. Thursfield, M.D.

Chairman:

Dr. Alfred Carpenter, J.P.

Chairman of Council of the Sanitary Institute.

The Chairman said they had met that day to listen to a very instructive paper by Dr. Thursfield, an able Medical Officer of Health, of the Midland Counties, who for a long time had been devoting his attention to the important subject which he was about to bring to their notice. Dr. Corfield, one of the Medical Officers of Health connected with the Metropolitan District, would read a paper upon the same subject. These papers, he was sure, would contain a large amount of material for consideration, digestion and discussion. He would especially ask that a subject which was peculiarly within the domain of ladies should not be left entirely to be discussed by gentlemen. Ladies could help with regard to work that had to be done in connection

with this important matter, so that he trusted that, as there were several present competent and capable of instructing them, they would give the meeting the benefit of their advice and assistance upon the matter.

HOW INFECTIOUS DISEASES ARE SPREAD.

By W. H. Corfield, M.A., M.D.
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We are able to prevent the spread of infectious diseases exactly in proportion to our knowledge of the ways in which they spread; and as long as we are ignorant of those ways so long are we unable effectually to control the spread of these diseases. Before we knew that over-crowding was an essential condition to the spread of typhus fever, and that the non-removal of excremental filth was essential to the spread of enteric or typhoid fever, we were entirely unable to cope with these diseases, but now that we have discovered those essential conditions, we are gradually, but surely, exterminating these two diseases.

The diseases which we have to consider are characterised among other things by being communicable from one person to another, directly or indirectly or both; we are, therefore, driven to the conclusion that something passes from the diseased person to the healthy person, and this we may call the poison of the disease.

It has been shown by Chauveau and others, from examination of liquids containing poisons of some of these diseases, that the poison exists in the form of solid particles, and is not in solution in the liquids; and other phenomena attending these diseases, especially the non-diffusibility of the poisons as shown by the limited extent of the infecting area around an infected person, leads us to the same conclusion. These poisons, then, are "particu-

late;" they are also, without doubt, organic substances, and many of the phenomena that they exhibit induce us to believe that most, if not all, of them are organised, that they are in fact living things, capable of growth and reproduction. They are of various kinds, and they "breed true:" the poison of one disease always producing the same disease in another person. Their mode of action in human beings and other animals exactly resembles the phenomena of putrefaction, which we know are attended by the presence of living organisms, especially in the existence of the stage of incubation which is eminently characteristic of all these diseases; and in this respect their action is totally unlike that of the mineral or vegetable but non-living poisons.

When an animal is given arsenic or strychnia it produces its effect as soon as it is absorbed, that is to say, almost immediately; but when a person is attacked by the poison of scarlet fever or of enteric fever it does not produce its effect at once, but only after a certain definite time, which we call the stage of incubation, and this phenomenon exactly corresponds to that which is observed when a small quantity of a substance in a state of putrefaction is added to a substance capable of undergoing that change. Moreover, in the cases of some of these diseases the specific organisms have been observed, examined under the microscope, and cultivated for successive generations. This was first the case with "anthrax," or "malignant pustule" (the "charbon" of the French writers); and within the last few years the poisons of several communicable diseases have been similarly determined. Whether these living organisms are the actual poisons of the diseases, or whether they invariably accompany these poisons and perhaps produce them, is a matter which little concerns us from our particular point of view; and we may therefore proceed as if it were established beyond all question that these organisms themselves are the poisons of the diseases.

When a sufficient quantity of one of these poisons is introduced into the body of an animal, it multiplies until it

produces the particular phenomena of the disease in question, the time that it takes before having multiplied to a sufficient extent to produce the commencement of these phenomena being the period of incubation before referred to.

During the progress of the disease, and in some instances at any rate even during the period of incubation, the poison is being excreted from one or other of the organs which separate waste substances from the body, *i.e.*, the skin, the lungs, the kidneys, and the alimentary canal; and when excreted from the body of a person suffering from the disease, it is conveyed in various ways to healthy persons. The substances which serve as agents for the conveyance of these poisons from the sick to the healthy we term "vehicles," and with these it is that we are especially concerned at present.

The atmosphere is the most universal medium or vehicle of communication for the poisons of these diseases; by it they are conveyed to the skin, to the mucous membrane of the mouth, the throat, the lungs, and, indirectly at any rate, through the swallowing of the saliva, to that of the stomach.

The poisons of some of these diseases are much more readily conveyed directly by the air than are the poisons of others, and, indeed, some of them produce an evident and characteristic smell in the air around the patient.

The smell of small-pox has been long known, and no doubt is referred to by the great Arabian physician, Rhazes, who in his first chapter, entitled, "Of the Causes of the Small-Pox, and how it comes to pass that hardly any-one escapes the disease," tells us that it is chiefly prevalent "in pestilential, putrid and malignant constitutions of the air." So, too, in the time of the Black Death, in the fourteenth century, the foul condition of the atmosphere was noted; we are told, for instance, that in the island of Cyprus "a pestiferous wind spread so poisonous an odour that many being overpowered by it fell down suddenly and expired in dreadful agonies." Again, as Haecker

tells us, "German accounts say expressly that a thick, stinking mist advanced from the east and spread itself over Italy, and (as he adds), there could be no deception in so palpable a phenomenon." During the prevalence of the sweating sickness a similar thing was observed, as Dr. Caius tells us, for in speaking of the cause of this disease he describes a mist which "was seen flying from town to town with such a stink in mornings and evenings that men could scarcely abide it." In the case of typhus fever, too, as Dr. Murchison says: "every physician who has had any experience of typhus must be familiar with the strong odour of the breath, and still more with that which escapes on turning down the bed-clothes of the patient. It has been found that those patients are most apt to communicate the disease in whom this odour is strongest; and there are many instances of persons being attacked with typhus a few hours or immediately after close contiguity with a typhus patient during which they had been strongly impressed with this pungent odour." In typhus fever, too, there can be no question that the disease is communicated directly through the medium of the air in the vast majority of instances, and that the infected area around the patient is very small, the poison being so diluted at even a short distance from the patient as to be incapable of infecting healthy persons. This disease is, therefore, only communicated from one person to another in overcrowded places; and when patients suffering from it are taken away into places that are not overcrowded, it is a fact that the disease does not spread. I have known several instances in which persons suffering from this disease have been brought into houses which were not overcrowded, but I have never known a single person contract the disease from them under such circumstances.

Scarlet fever, measles, and whooping cough are also, like the preceding ones, diseases in which the poisons are given out into the air around the patient, and so the air becomes the chief infecting medium. These are diseases which are largely spread in schools, and especially in infants'

schools; and during the prevalence of epidemics of these diseases it is often necessary to close these schools altogether for a time. In measles, however, it is sometimes sufficient to prevent all children under five years of age attending school until the epidemic has abated.

The poisons of some of these diseases are more especially conveyed in the foul air of sewers and drains. This is the case with enteric or typhoid fever, the poison of which is chiefly, if not entirely, discharged from the body by means of the intestinal canal, and with diphtheria.

In the case of enteric fever the disease is no doubt sometimes contracted directly from the foul air, the poison most probably being swallowed with the saliva, although Dr. Budd was of opinion that enteric fever was very frequently conveyed by direct contagion through the medium of the air. In the case of diphtheria, a disease which has its special manifestations in the throat, the poison is most generally conveyed directly through the medium of the air; and in cases where diphtheria itself is not actually produced, the breathing of such foul atmosphere is commonly attended with the production of non-specific sore-throats.

Of course, foul air escaping into the house is far more often the cause of the mischief than when it is allowed to escape into the open air, in which case it gets diluted and soon loses its infective power; but I have known one undoubted instance in which a person contracted enteric fever from the emanations from a blocked-up drain which was opened outside the house. There was no question of contaminated water supply, and this person was the only one among a great number of servants in a very large country house who contracted the disease. I was able to show how the poison got into the drain; and the reason why this one servant got it while the rest escaped was that she was in a feeble state of health from overwork. This instance shows not only that the disease may be communicated occasionally directly through the air, but that under such circumstances the majority of people in good health do not contract it.

The foul air from sewers and drains gets into houses through defective drains, soil-pipes, and other sanitary apparatus. It is not at all uncommon in houses to find bell-traps in the basement-floor leading directly into the drain, and this into the main sewer; these traps having been disused for some time, being perfectly dry, and allowing a passage of sewer-air into the house only partially obstructed by the dust and dirt which collects in the trap. Foul air eats holes in unventilated lead soil-pipes and traps, and so finds its way through numerous small fissures and holes into the house continuously, but more freely at night, when the doors and windows are shut and the fires lighted.

It has been shown that the poisons of several of these diseases may be conveyed by means of clothing, even when the persons conveying them are not suffering from the disease itself. This is notably the case in typhus fever, as was seen in the instance of the Black Assizes, where prisoners, not suffering from gaol-fever themselves, infected by means of their clothing, policemen, jurymen, and even the judges in the courts. It is probable that several of these diseases are very frequently conveyed in this way; I know, for example, an instance in which chicken-pox was introduced into a house by a gentleman who had been playing with his children who were suffering from the disease, without his even seeing the children who shortly afterwards contracted it in the house where he paid a morning call; and there are no doubt many such instances that are never traced.

Fortunately, it appears necessary that the poison should be in a very concentrated condition to be conveyed in this manner, as otherwise its conveyance by medical men and attendants on the sick would be very much more frequent than it is at present.

These poisons are sometimes spread through the agency of laundries, both by infected clothing being sent to these establishments, and also by the presence of a case of one of these diseases in the family of a laundry keeper.

There can be no question, too, that it is a most dan-

gerous thing for persons suffering from such diseases to travel in ordinary public conveyances, as from being shut up in these they are liable to infect them very virulently, and thus to be a source of great danger to other persons using the conveyances. This is very properly an illegal act, but it is nevertheless impossible to prevent it occasionally being done. I remember an instance in which a servant girl suffering from small-pox was about to be taken to the hospital; she sent her fellow servant out for a cab, went down-stairs, got into it and drove away to a railway station, and thence went to her home in the country. We were able to identify the cab, and found that it had been afterwards used to take some ladies to the opera, and at a later hour in the evening to convey to their homes some Members of Parliament from the House of Commons. I am not able to say that the disease was spread in this way in this particular instance, but it is very possible that it was.

These poisons attach themselves to wall-papers, and the wall-paper should be removed and burnt after a person suffering from one of these diseases has inhabited a room.

In some instances they are communicated by means of letters, and Dr. Bristowe has given me an interesting example of this in the case of chicken-pox, which was communicated to some children while staying at Hastings in a house where there was no case of the disease by letters from the mother of a family then suffering from it. He has also mentioned to me an instance of a family in which the boys covered with small-pox scabs were cutting nibs for quill pens for the stationers; in fact, there is probably scarcely any article of household use which may not under certain circumstances become the means of conveying the poison of one of these diseases.

Drinking water is also a most important vehicle for the conveyance of the poisons of some of these diseases. That water is capable of being polluted by such poisons has been recognised from very early times, and is even

mentioned by Virgil in his Third Georgic in the following lines, which I quote from Dryden's translation :—

> "Here from the vicious air and sickly skies,
> A plague did on the dumb creation rise,
> During th' autumnal heats th' infection grew,
> Tame cattle and the beasts of nature slew;
> Pois'ning the standing lakes and pools impure,
> Nor was the foodful grass in fields secure."

In the middle ages, too, the Jews were accused of spreading the black death by poisoning the drinking-water.

The diseases that we recognise as especially spread by means of polluted drinking-water are cholera and enteric or typhoid fever, with dysentery in hot countries; and there is also a certain amount of evidence that diphtheria may be spread in the same way. The poisons from these diseases get through leaky drains and cesspools, and through the soil into the wells, or they are carried by sewer-air into the cisterns in which drinking-water is stored, through overflow or waste-pipes connected with the drains, soil-pipes or water-closet apparatus; or they are conveyed by sewers and drains into water-courses which are afterwards used for the supply of drinking-water. The conveyance of the cholera poison by means of drinking-water was first pointed out by Dr. John Snow in the year 1849; he says, speaking of this disease: "there is often a way open for it to extend itself more widely, and to reach the well-to-do classes of the community; I allude to the mixture of the cholera evacuations with the water used for drinking and culinary purposes, either by permeating the ground, and getting into wells, or by running along channels and sewers into the rivers from which entire towns are sometimes supplied with water." Dr. Snow traced cases of cholera to polluted water in 1849, and again in 1854, when the celebrated outbreak in the case of the pump in Broad Street, Golden Square, took place, in which case the disease was traced to the drinking of water from that pump; and the evidence was rendered very conclusive

by the fact that a lady in Hampstead, who had not been in the neighbourhood of Broad Street for many months, but was in the habit of having a bottle of water from the Broad Street pump taken up to her every day, was seized with cholera on September 1st—the day on which the severe outbreak in the neighbourhood of Golden Square commenced—and died the next day. A niece who was on a visit to her at the time also drank of the water; she returned to her residence in a high and healthy part of Islington, was attacked with cholera, and died also. The evidence no doubt was so complete that Dr. Snow was quite justified in saying: "Whilst the presumed contamination of the water of the Broad Street pump with the evacuations of the cholera patients affords an exact explanation of the fearful outbreak of cholera in St. James's parish, there is no other circumstance which offers any explanation at all, whatever hypothesis of the nature and cause of the malady be adopted."

Succeeding epidemics have been traced to the same source, and Dr. Snow's dictum has been found to be true in each instance; in fact, as he says: "Each epidemic of cholera in London has borne a strict relation to the nature of the water supply of its different districts, being modified only by poverty and the crowding and want of cleanliness which always attend it."

So large a number of epidemics of enteric or typhoid fever have been traced to drinking water polluted with the poison of the disease that it is hardly necessary to single out any one; I will merely mention a case that came under my own observation: at a small fishing town on the south coast of Cornwall, where the midden heaps and cesspools universally drained into a small stream from which the drinking water was obtained, but where there was no case of enteric fever, nor where there had been any case of enteric fever for years, a young man was brought home unwell to a house situated at the upper end of the town; his illness proved to be typhoid fever, and within a short space of time the disease was

raging all over the town, which was universally supplied with water from the stream in question. There can be no doubt at all that in this instance the water proved the vehicle for the conveyance of the poison. In London, and many other large towns, this disease is chiefly spread by the pollution of water by means of sewer-air containing the poison of the disease, which finds its way into the cisterns through overflow or waste-pipes connected with the drains or soil-pipes; and thus it is quite impossible to trace the disease from one house to another; indeed, whether in towns or in the country, it is quite useless to expect that we shall ever be able to trace the majority of the cases of this disease, for a person may go about with it for two or three weeks, without knowing that he has got it, leaving the poison behind him wherever he goes; and so we are not justified in any case where we are unable to trace the history, in assuming that the disease has originated apart from a previous case.

Diphtheria has not been usually recognised as a disease conveyed by means of drinking water, but some interesting examples brought by Dr. Browning before the Society of the Medical Officers of Health make it very evident that, occasionally at any rate, this disease is spread in the manner in question; however, there can be no doubt that while enteric fever is generally contracted by means of polluted water and occasionally by means of polluted air—diphtheria is generally contracted by means of polluted air, and only occasionally by means of polluted drinking water. Such diseases as are conveyed by means of drinking water may also be conveyed by milk when mixed with polluted water, but as this subject has been so thoroughly treated by Dr. Thursfield in his Paper, I need not further allude to it.

Other foods may become vehicles for conveying these poisons, and I have known instances of some of these diseases breaking out in houses where there were traps in the floor of the larder connected with the drains, or defective soil-pipes in the walls. Foul air, too, which may contain

the poisons of these diseases, frequently gets into larders through the runs which rats make from the drains, and thus the food becomes contaminated. It has been shown that in some instances flies convey the poisons of infectious diseases from place to place. It had long been suspected that the poison of anthrax or malignant pustule was conveyed from one animal to another by means of biting or stinging flies, but it was shown by M. Raimbert that this was not correct, but that the poison in question was transmitted by means of ordinary house-flies and meat-flies; and there can be little doubt that the poisons of many other diseases may be communicated in the same way.

Lastly, the poisons of some of these diseases may be said to infect the ground, which may thus become a source of disease to others. As Dr. Budd says of enteric fever: "like malignant cholera, dysentery, yellow fever, and others that might be named, this is one of an important group of diseases *which infect the ground*, hence the quasi-miasmatic character attached to them all which has misled so many observers as to their true mode of spreading."

Having finished this brief review of a vast and important subject, I would point out that, as we are, I may almost say, continually discovering new ways by which the poisons of these diseases are spread, so we have no right to assume that in any case the poison has not been communicated in a manner at present unknown to us; still less on such slender grounds are we justified in assuming that the poison has arisen independently of the existence of a previous case of the disease.

ON COWS' MILK AS A VEHICLE OF INFECTIOUS AND EPIDEMIC DISEASE TO THE COMMUNITY, WITH SUGGESTIONS FOR THE MORE EFFECTUAL PREVENTION OF SUCH OUTBREAKS.

By W. N. THURSFIELD, M.D.

TO fully consider the above subject would involve questions in comparative and human pathology which would of themselves more than occupy the time at my disposal on the present occasion. I shall therefore endeavour to confine my remarks to generally acknowledged facts, moulded as far as possible by personal experience, and to suggest such remedial measures as shall be immediately practicable and equally efficacious and advisable, whatever technical views may be held as to the extent and precise mode in which cows' milk becomes a vehicle of human disease.

The subject is one with reference to which it is specially desirable on the one hand not to create undue alarm, and on the other hand not to make light of or pass over apparent sources of disease, however improbable they may appear at first sight. It is, however, one of growing importance. Milk is daily becoming more recognised as the staple food for children, and from a variety of causes it is, I fear, a fact, that year by year the proportion of women physically incompetent to suckle their offspring is increasing. The use of milk by adults has of late enormously increased, and although I cannot but consider that to drink milk as a beverage with heavy meals is a grave dietetic error, the modern practice of drinking glasses of milk instead of beer at railway refreshment bars and elsewhere is certainly not to be condemned.

The greatest risk of danger from milk lies however in the

fact that the chief consumers are of an age when the body is most susceptible of taking disease, and the consumption of unboiled milk may literally be said to bring the consumer into close connection with the animal from which the milk was drawn, and, always to some extent and often most intimately, with the family and domestic arrangements of at least one household and often two. That the above inevitable connections may be rendered as free as possible from danger to the milk consumer is the aim I have in view on the present occasion.

When we consider that a considerable proportion of animals yielding milk are in that parturient condition which is specially prone to sickness, and when we also consider to what extent milk is a reflection of the bodily condition of an animal and of its food, and how very absorbent milk is of volatile matters in the atmosphere, equally liable to take up and taste of any peculiar odour, organic or inorganic, as to be affected by putrefactive emanations, and, even in the absence of such, most prone to undergo septic changes, the wonder is not that so many but that so few bad consequences have been hitherto traced to its door.

As cases of infection through milk can only be considered absolutely proved when there is no other condition in common to the sufferers or probable door of infection, the cases adducible as such must as a rule be restricted to epidemics occurring where milk is retailed to a number of families at a distance from the original source of supply and to diseases to which some members of most families are susceptible. It is therefore presumable that in many cases of disease from milk the source has not been suspected, as the evidence has not been sufficiently salient to attract attention.

To Dr. Michael Taylor, of Penrith, is, I believe, due the credit of having in the year 1858 first recorded a milk epidemic in an account of an epidemic of typhoid fever. The subject appears not to have attracted much attention until Dr. Ballard's well-known report of an epidemic of typhoid fever in Islington in the year 1870, since when records of about a hundred epidemics, alleged to be

traceable to milk dissemination, have been published, and others not published have been noted.

The connection of an epidemic with milk supply is a matter with regard to which the statistical method, unless applied with scientific accuracy and rigorous impartiality, may readily lead to a wrong inference and a coincidence be recorded as a consequence, and this would doubtless apply to some of the epidemics recorded. As an instance of how coincidences, presumably most improbable, do occur, I may state the following. A few weeks ago I received a letter from a medical officer of health in one of our largest towns to say that an epidemic of typhoid fever in his district had been clearly traced to a milk retailer who received all his supply from a farm-house in my district, and asking me to be good enough to investigate the matter locally. I immediately visited the farm and found that there was no typhoid at or anywhere about the locality of the farm, and the sanitary arrangements and water supply were satisfactory. I found, however, that the farm in question was infected with foot-and-mouth disease (*Eczema epizootica*), but that the infected animals were carefully isolated and none of their milk sold. The farm happened to be the only one in that part of the country so infected. Whilst I was pondering as to how best to meet the conclusion that I feared some would inevitably come to, viz., that the disease of the cattle had been transferred to human beings in the shape of typhoid fever, I received a second communication from the medical officer of health above referred to, saying further investigation had revealed circumstances on the retailer's premises amply sufficient to account for the epidemic of typhoid.

Making allowance for all doubtful cases, it may, I think, be accepted as an absolute fact that epidemics of typhoid fever and scarlet fever have been repeatedly disseminated by milk, and that there is very strong evidence that diphtheria has been so disseminated, and instances have been adduced by most competent observers. Other infectious diseases have been alleged to have been so transmitted, but the cases are not so numerous nor the evidence so clear.

If, however, we accept the transmission by milk of the diseases above named, we are justified by our knowledge of the nature of infectious diseases generally in assuming that to a certain degree the same danger may exist in the case of all infectious diseases, and should be guarded against.

With a view to propose efficient preventive measures it is necessary to consider the probable mode in which milk becomes a vehicle for the germs of infectious disease. I am certainly expressing my own opinion, and I believe also the opinion of the majority of those who have carefully studied the subject, that this is a point on which we have as yet very little accurate knowledge. In the case of the majority of milk epidemics investigated, typhoid fever has been the disease involved, and in the majority of such cases specifically contaminated water added to the milk has been regarded as the source of the evil. This doubtless has been the case in many instances, but this theory does not appear to satisfactorily explain all the epidemics of typhoid fever, and less so the epidemics where scarlet fever or diphtheria has been the disease involved. Another possible explanation is that the milk may be a simple carrier of the disease in the same way that articles of clothing convey the germs of disease. This may explain some cases. There still however remain a considerable number of epidemics in which the above explanations do not suit the observed facts. Another explanation is that milk itself may become specifically infected and serve as a nidus for the disease germs, in other words, may itself catch the disease. Certainly milk is specially calculated by its composition to act as a cultivation fluid for germs proper to the human body, though it is difficult to believe that it would readily so act at the ordinary temperature. The temperature of healthy milk, taken as soon as practicable after the milk has been drawn from the cow, will be found to be from 99° to 100° F. We have therefore in milk, warm from the cow, a fluid specially suitable in composition and condition to afford a favourable seed-bed for the germs of infectious disease, supposing them to be capable of cultivation or development

outside the human subject. Now, supposing freshly-drawn milk to be brought in contact with such germs, through the medium of either air, water, or an individual infected in person or clothing, it is certain that the milk would not destroy these germs, and it is not unreasonable or discordant with analogy to assume that the milk might favour the development and even multiplication of such germs, and thus attain a more uniformly diffused power of infection than it could do as a mere mechanical carrier of the infection. It is indeed remarkable in what a number of instances the above explanation would accord with the observed facts, and specially it has been recorded in the majority of milk-scarlatina epidemics that the cows had been milked by persons in immediate and close contact with that disease. The advantages of artificial cooling of milk, in improving its keeping properties, are so well known that it is unnecessary to call attention to the above as an additional reason why milk should be refrigerated.

Another suggestion is that milk epidemics may be explained on the hypothesis that the disease is a vicarious expression in the human subject of some apparently different disease in the animal. If this were the case those engaged in investigations into the origin of outbreaks of infectious disease would be expected to find a larger percentage of inexplicable cases (i.e. cases where the source of infection was not readily traceable) at farm-houses or cottages where cows were kept. Such is, however, certainly not the case in scarlet fever or typhoid fever. In diphtheria I will not give a positive opinion, and it has struck me that very frequently outbreaks in which the source of infection was not readily traceable, have appeared in connection with a certain class of small farms where a few cows were kept, but this fact, if fact it be, may be explicable by the natural history of diphtheria, as in this disease, essentially a disease of rural districts, structural dampness of habitation is of all defects the one most favourable to severity of infectious sore-throat (too frequently not called diphtheria unless severe and marked by development of a membrane

in the throat), and to the persistent vitality of the infection, and to its recrudescence often at intervals of years; and the class of houses to which I allude are often imbedded, in damp situations or on a water-logged subsoil, and structurally damp, and in some cases have probably remained with little alteration from the day when they were first erected and the choice of locality chiefly influenced by proximity to water and rich pasturage.

Calves occasionally suffer from a throat affection presenting post-mortem appearances very similar to those found in human diphtheria. Assuming the identity to be something more than apparent, it is obvious that cows milked after temporarily giving suck to such calves could very readily contaminate the milk. I have not been able to obtain any evidence of the coincidence of this disease in calves with human diphtheria in the same locality, and, for technical reasons unnecessary to detail, the practice of only partially milking cows would, in the case of regular milk sellers, be exceptional.

It has more recently been suggested that the infected condition of the milk may result from the animal being itself the subject of the disease, contracted either directly from some case of human infection or remotely and after the infection had previously passed through other animal subjects. We know that in mankind the parturient condition renders a mother peculiarly susceptible to take zymotic disease, and that in such cases salient symptoms of the specific zymotic disease are masked and suppressed, and it has been suggested that something of the same kind may take place in the case of the parturient cow, but that the disease is modified, and instead of being severe, as is generally the case under similar conditions in the human subject, is so slight as not necessarily to attract attention. This theory is supported by experimental evidence. Dr. Klein, by inoculating a cow, recently calved, with the virus of scarlet fever, appears to have succeeded in producing a febrile ailment which proved transmissible to dogs by inoculation, and produced in them

an apparently specific disease. The theory also receives some indirect support from certain exceptional features which are said* to have been observed in the character of the disease in milk-scarlatina, viz., exceptionally mild type of disease and little tendency to spread by personal infection. I have, however, certainly noticed exceptional mildness of attack, and I am disposed to think a diminished tendency to spread, in several epidemics of typhoid fever which had undoubtedly been disseminated by the agency of water. The above theory could not, however, apply to those instances in which the milk has been assumed to have become infected after it has been removed from the dairy farm.

In addition to recognised human diseases, milk may become a vehicle for the transmission of recognised bovine disease to man. That the infection of foot-and-mouth disease (*Eczema epizootica*) can be so transferred there is no manner of doubt. Numerous instances have been recorded. Some nine years ago I published a very distinct case, and could now adduce other instances. When, indeed, we consider how sensitive the secretion of milk is to the general constitutional condition of the animal, and that the first symptoms of illness noticeable in cows is a sudden and marked diminution in the yield of milk, and that even the consumption of milk from over-driven and heated, but healthy animals, has been known to produce severe intestinal disturbance, it is difficult to believe that the milk from a diseased animal can be otherwise than injurious. We are, however, met with very contradictory evidence. I know instances where children have been freely allowed to drink milk some portion of which came from cows suffering from infectious eczema, and without injurious results, and there is abundant evidence of the consumption of the milk of animals suffering from pleuro-pneumonia without any ill effect.

No amount of negative evidence can, however, upset

* See report by Dr. Power in the supplement to the twelfth annual Report of the Local Government Board.

positive cases, and we are justified in the conclusion that if there is considerable uncertainty, there is sufficient evidence of risk to render it necessary to take such precautions as are indicated by experience.

It is asserted by some high authorities that bovine tuberculosis is transmissible to man. That a considerable proportion of milch cows are affected witn tubercular disease is admitted, but whether the disease be or be not transmissible to the human subject through the milk is a matter difficult to prove, and a point about which there is much controversy, though considerable evidence of probability has been adduced. If such transmission can be satisfactorily proved or even shown to be frequently probable, the question of this disease would then transcend in importance any previously referred to by me. To eliminate or even to recognise every animal infected with tubercular disease in a herd of milch cows would be most difficult, and the question of the prevention of the disease in cattle would involve agricultural considerations of the highest importance. As, for instance, one cannot but think that the very customary practice of rearing store calves upon milk deprived almost entirely of its natural fat must be a powerful predisposing cause of tuberculosis. This question of the possible transmission of bovine tuberculosis to mankind is one which demands thorough investigation. All we can venture to suggest as practicable at present, is that no milk should be sold from cows in a recognised stage of tubercular disease.

It is, however, an acknowledged fact that cows fed in urban cowsheds are much more prone to this disease than those fed in the ordinary way in the country, and if the recent large development of the milk trade from the country has had the disadvantage of prolonging the interval during which milk is kept before being delivered to the consumer, and thus affording more time for septic action, this is more than counterbalanced by the lessened danger of the milk being derived from tuberculous animals.

It does not need any evidence of illness produced, although such evidence could be adduced, to emphasise the

requirement that purulent matter from abcesses or local inflammations of the udder should be carefully excluded from milk intended for human food, and therefore that milk from animals so suffering should not be sold. Nor need I more fully refer to cases of illness which have obviously been caused by milk of cows which had fed on plants possessing irritant properties, and which had been taken up by the milk. Such cases are most exceptional in this country.

There have, however, recently been recorded outbreaks of epidemic sickness traceable to milk which, although presenting features agreeing with no recognised human or bovine disease, have presented sufficient uniform characteristics to entitle them to be considered as belonging to a specific disease. The question is, do these symptoms depend upon some epizootic disease transferred to the human subject (and it would be in accordance with analogy and experiment that an animal disease, when transferred to man, may present symptoms varying in degree and kind from those which it originally presented), or are the symptoms the result of the evolution, under favourable conditions, of a special degree of virulence in septic germs received from without, and not in any way connected with the animal source of the milk? The cases appear to present very close analogy with the so-called pork sickness, and in three somewhat extensive outbreaks of this disease which I have been called upon to investigate (records of which are in possession of the Local Government Board), where the disease has presented sufficiently definite characteristics to entitle it to be considered a specific disease, the balance of evidence has appeared to me to be in favour of the theory that the results were due to the latter cause, and not dependent upon an original diseased condition of the animals. It is, however, noteworthy that in all these three outbreaks the pigs had probably been fed upon dairy refuse.

One notable fact in connection with milk epidemics is that they have generally occurred in connection with milk

purveyors who have been under contract to supply a certain amount of milk daily, to be subsequently retailed. This is possibly open to the explanation that in such cases only can the necessary statistical evidence be forthcoming and attract attention. It is, however, I trust no libel on human nature to say that milk purveyors so situated would have greater inducement to continue the use of milk from cows suffering from slight illness, or to bring into trade use milk from parturient animals earlier than would otherwise be done, and, assuming the animals to be the source of the mischief, the mixed milk of twenty cows would at all times be very much more dangerous than the milk of twenty cows used separately. Although in acute disease the quantity of milk is decreased, the secretion does not generally cease altogether; and it is an important part of the treatment and essential for the well-being of the animal that it should continue to be regularly milked, and some people would probably honestly believe that if this milk was mixed with a large quantity of wholesome milk, no harm could ensue.

It is a popular belief that if the provisions of the Adulteration of Food Act are actively put in force, and the duties of the public analyst efficiently performed, sufficient protection is afforded against evils traceable to milk supply. Chemical analysis, especially when applied to mixed milk from a number of cows, although indispensable to expose a marked addition of water or abstraction of cream, is valueless as an indicator of infected milk, and, as negative evidence of danger or positive evidence of infection, is as fallacious in the case of milk as it is in the case of water.

There are certain circumstances under which, when the individual members of a community cannot well protect themselves, it is recognised to be the duty of the State to furnish as far as possible the necessary safeguards. This principle as applied to milk has already been endorsed by our legislature, and acted upon in sec. 34 of the Contagious Diseases (Animals) Act, 1878, and by the Order in Council

of July 1879, founded on the above section, and known as the "Dairies, Cowsheds, and Milkshops Order." I propose now to bring under notice the practical working of this legislation with a view of considering what measure of protection is afforded by it to the consumer against the risk that, with milk, the germs of disease may not be introduced into households. I think the answer must be not only that it affords no sufficient protection, but that, in those districts from which disease has been most frequently so imported, the risk is in some respects greater than before such legislation; and the reason I believe to be that this important matter, instead of being placed prominently under the operation of the laws relating to the health of mankind, has been made to occupy a very secondary and subsidiary place amongst the statutes relating to diseases of animals. Nowhere can it be considered a purely local question. In fact, it is almost the widest we have to deal with, as from some of the rural districts for which I act as Medical Officer of Health, quantities of milk are consigned in bulk to Manchester, Liverpool, Birmingham, and London. It is not sufficient that a sanitary authority in London, we will say, should have power, as at present, to regulate its own milkshops, or even interdict any suspected source of supply. There ought, in addition, to be some reasonable assurance that efficient precautions are taken at the source of the milk supply, to which their local precautions can only furnish the necessary supplement.

The public, guided probably by common-sense ideas of the fitness of things, whenever milk has been proved to have conveyed infection from one district to another, invariably appear to blame the sanitary officials of the district from which the disease was imported; whereas, as a matter of fact, the statutory duty of enforcing the necessary measures of isolation in outbreaks of such diseases as scarlatina, diphtheria, or typhoid fever, in dairies, &c., has been so far taken out of the hands of Medical Officers of Health and Sanitary Inspectors, by being made the subject of special legislation, which places the inspection and

control in such matters of dairies, cowsheds, and milkshops in the hands of Inspectors under the Contagious Diseases (Animals) Act.

The local authorities for the administration of the above Act are various, but (with the exception of that part of London under the control of the Metropolitan Board of Works) the whole of England may be broadly divided into districts (boroughs) in which the local authority for the administration of the above Act is necessarily the same body as that which administers the laws relating to human public health, and districts (non-corporate) in which the local authority is the Court of Quarter Sessions, always a distinct body from the sanitary authority. The districts last referred to include nearly all rural districts, and the vast majority of the dairy-farms from which milk is transmitted in bulk for subsequent sale by retail. Speaking from personal experience of considerable portions of seven counties, and from what I have been able to learn of other localities, it is in these districts that more efficient supervision is most desirable, and it is from such districts that infectious disease appears to be most frequently transmitted in the milk-tin. Why is this? Is it because in these districts the local authority is a distinct body from the sanitary authority, or is it for some other reason? I believe the latter, and that the failure is chiefly owing to the fact that the carrying out of the provisions of the Legislature has devolved upon officials who are not to be blamed if they have failed to comprehend the importance of and the method of doing certain things requiring considerable technical knowledge, but for which they have had no technical training whatever.

The executive for carrying out the Contagious Diseases (Animals) Act are, by the provisions of the Act, police officers, who have the power of calling in veterinary inspectors, a machinery doubtless well adapted for the original purpose of the Act, viz., the prevention of the spread of epizootic disease amongst cattle. Local authorities

have power to appoint other and special inspectors, but such appointments are most exceptional.

The statutory provisions which have to be enforced under the above Act by the inspectors are, shortly, that every dairy, &c., shall be provided with proper water supply, and so drained, &c., as to obviate the risk of contamination of the milk by means of sewer emanations or in other ways, and that on the outbreak of any infectious disease amongst the employés, precautions shall be taken to enforce isolation of infected persons from contact with the milk, "until," to quote the words of the Order, "in each case all danger therefrom of the communication of infection to the milk, or of its contamination, shall have ceased." Now with reference to these requirements, every one must admit that if there is anything in the application of trained knowledge to structural works of drainage, or in the application of medical science to the prevention of disease, trained sanitary officials are not only the proper persons, but the only persons to whom such duties should be entrusted. As a rule, the eye only sees what it has been trained to see, and the mind only appreciates what it has learned to appreciate. A police officer, or indeed any officer, however zealous and intelligent, could not be expected without previous training to know if a place where milk was kept was drained with precision; and how could he appreciate the precautions "necessary to ensure the absence of all danger of the communication of infection to milk;" and his opinion as to the wholesomeness or otherwise of a water supply would probably not be more valuable than that of any other non-technically educated person.

To take another very practical point, it is my experience in a large number of epidemics of diphtheria—and the same remarks apply to some extent to scarlet fever and typhoid fever—that the most fertile sources of infection are very slight cases of the disease unattended by a medical man, and probably spoken of as merely colds. Now, how can a police officer, or similar individual, be expected to rightly appreciate the occurrence of several cases of sore-throat in

a family during a prevalence of diphtheria, or of the by no means uncommon instances in which scarlet fever is unaccompanied by any rash.

It may be said that by being placed under such jurisdiction as I have described, a dairy does not cease to be an occupied house for the purposes of the Sanitary Acts. This holds good to a certain extent, and is the view which I have practically adopted in my course of action in such districts; and I have very frequently stopped the sale of milk, using merely the prestige of my office rather than any legal power. But it is nevertheless true that in making any trade or calling the subject of special legislation, the Legislature has indicated to what jurisdiction the calling or building is primarily responsible, and under what Act and by whom proceedings should be taken. And if it became necessary to take proceedings with a view to stop the sale of milk which was presumably infected, the medical officer of health could only do so by calling in the Contagious Diseases (Animals) inspector. In this respect we are even worse off in cases requiring prompt action than before the passing of the Act in question. As an instance, a few years ago, on a milk-seller declining to discontinue the sale of milk which had undoubtedly been exposed to the infection of scarlet fever, I had the milk seized as an article of food that was unsound and unwholesome, and on my evidence to that effect a conviction and fine ensued.

To place all dairies in rural districts under the same regulations as apply to cowsheds in large towns would be an unnecessary interference. Already milk is too difficult to obtain by the cottage class in many rural districts, and every care should be taken not to render this more difficult. A wide distinction should be drawn between milk purveyors and ordinary cow-keepers. The milk purveyors should be alone subject to the special regulations and license. The term purveyors should be restricted to those who sell milk by retail by sending it round from house to house, or keep shops where milk is sold as a prominent article of trade, or transmit milk in bulk to a distance for

subsequent sale by retail. All such purveyors should be subject to licence. Regulations are of course necessary, but what is chiefly needed is efficient inspection and responsible advice under certain exceptional difficulties.

To effectually prevent milk epidemics precautions are necessary :—

(*a*) At the house of the consumer.
(*b*) At the milk-shop of the retailer.
(*c*) At the dairy farm of the wholesale purveyor.

(a) *Precautions advisable at the house of the consumer.*

If there is one fact which more than another has been uniformly brought out in the records of milk epidemics, it is that the consumers of boiled milk have, as a rule, escaped, and the same fact has been noted in outbreaks of an American epizootic which is readily transmissible to man, known as the milk sickness. The same protective influence of boiling infected milk has been observed abroad in connection with the experimental transmission of bovine tuberculosis to other animals. To boil milk may, for practical purposes, be said to confer immunity from infection conveyed by it, though such should never be absolutely relied upon, or when milk is known to be infected. At the present day in this country, milk is the only animal product which is habitually consumed in a raw state. Milk is food and not medicine, and there is no dietetic reason why milk should not be always cooked before consumption ; in fact rather the reverse, and the antiseptic and preservative effects of even partially cooking (scalding) milk are well known. The objection of many on the score of taste would disappear with use, as taste is very much a matter of cultivation. If bread and milk and puddings were the only uses to which milk was applied, there would be no difficulty in recommending that no uncooked milk should be eaten, but boiling milk produces certain physical alterations which interfere with its subsequent general use when cold, and causes considerable prejudice against the obvious pre-

caution of just boiling the milk in bulk when received from the retailer.

The above objections do not apply to cream; and I am in a position to state, on the authority of an eminent *chef* who has tried the experiment, that there is no culinary mystery in which cream is used for which boiled cream is not as readily applicable as unboiled.

(b) *Precautions advisable in connection with the milk-shop of the retailer.*

Generally those adopted by urban sanitary authorities, with the addition that, on the occurrence of any infectious disease amongst the employés, the fact should immediately be notified to the proper authorities.

An urban sanitary authority should also have the power to stop the sale of milk consigned from any particular farm pending investigations, if satisfied that they have sufficient grounds for so doing, but should be liable for compensation if the step prove to have been uncalled-for or unnecessary.

It should also be incumbent on a retailer of milk, when required by the sanitary authority, to furnish a list of his customers.

It has been suggested that milk retailers should be required to adopt such a system of book-keeping as would enable the farm source of the milk supplied to any particular house to be at once identified. Such a requirement would, I fear, be to some extent impracticable and certainly harassing.

(c) *Precautions advisable at the dairy farm of the wholesale purveyor.*

In connection with the above subject, there is much that is theoretically desirable that is at present not practically attainable; I believe, however, that it is possible, without omitting any requirements absolutely essential to safety, to

restrict the compulsory provisions to such steps as are practicable under existing conditions. The requirements as to cubical and floor space and ventilation, of the regulations generally adopted in the case of urban cowsheds, are unnecessary in the case of dairy farms, and I fear that in the case of rural cow-houses, requirements as to washable wall surfaces and impervious flooring could not at once be complied with, and the same would apply to the requirements as to daily registering the quantity of milk given by each cow, and taking the animal's temperature, and the restrictions as to feeding, incorporated in the regulations adopted in some parts of Germany.

There are certain requirements, however, which are essential and not unreasonable.

The premises on which the business of a milk-purveyor is carried on should be registered with the local authority.

Every registered dairy should be provided with a plentiful supply of good potable water for the use of the dairy and cows. Dairy-farm proprietors need be under no alarm at this requirement. It is a very different matter from requiring every house unprovided with water on the premises to be furnished with such supply at any cost. It is essential for the conduct of a dairy farm at all that there should be water for cattle and dairy purposes, and the business would not be attempted under other conditions. To require that the water be of good quality should entail no additional trouble. By good potable water I do not mean water coming up to an arbitrary chemical standard, but the uncontaminated water of the district, *i.e.* wholesome water free from animal or sewage contamination, or excess of organic matter, and, which is most important, so situated as regards its source, and so protected as regards its storage as not to be liable to pollution by sewage. That the water connected with country houses does not as a rule come up to the above requirements is simply because no care has been taken in selecting the spot on which the well is sunk, and no precision used in protecting wells or other reservoirs from obvious sources of contamination. About such

houses there are always spots where it is very undesirable to place a well, although such are generally selected, convenience of access being alone considered; but there will also nearly always be found a choice of situations not open to objection, and where care in protecting from surface infiltration will ensure good water. In short, good water can as readily be obtained as bad.

The dairy used for storing and treating (refrigerating, &c.) the milk should not be subject to animal effluvia of any kind, and should be satisfactorily drained, *i.e.* with no drain end (unless disconnected) inside it, and the dairy should not be used for general domestic purposes.

Under the following circumstances the milk should not be transmitted for sale :—

Milk presenting any marked deviation from ordinary appearances, in either colour, smell, or general condition.

Milk from an animal manifestly the subject of constitutional disease.

Milk from an animal suffering from acute disease or infectious disease of any kind.

Milk from an animal suffering from abscess, inflammation or painful swelling, or other affection of the udder.

Milk from an animal that has not completely recovered from the febrile state and other symptoms incident to parturition.

On the occurrence in an animal of any symptoms of acute disease, or a large and sudden diminution in the yield of milk, the milk should be set aside.

On the occurrence in the person or family of any one employed about the cows or the dairy of any eruptive or infectious disease at all, or of any throat complaint affecting three or more persons, the affected individuals should be isolated, and the fact notified to the health officer.

In most of the above requirements the milk-purveyor would be a gainer, as he would always be in a position to avail himself of responsible advice. Notification of disease need not, for obvious reasons, entail publicity, but in such

cases the responsibility of the necessary isolation would devolve on the medical officer of health.

I believe, indeed, inspections may be so carried out that the inspector would come to be looked upon, not as an interloper only borne with so far as the law demands, but as one in a position, under certain circumstances of disease incidence, to give advice, valuable from a commercial as well as from a sanitary point of view.

Whatever differences of opinion there may be on technical points and matters of detail, I think that all who have carefully considered the subject will have formed a decided opinion that the adoption of regulations as to the sale of milk should be incumbent on local authorities, and not permissive, as at present, and that the regulations should be applied at the producing as well as the distributing depôts.

I am induced to add a few words with reference to butter, not only because the subject of milk cannot be said to have been completely considered without some reference to butter, but chiefly because its consideration furnishes the key-note to the only true and final solution of the whole difficulty, viz., the practical extinction of the infectious fevers in rural districts.

Butter-making is the most profitable branch of dairy industry, and is the one most commonly pursued, especially by those who only keep one or two cows; and for one person who transmits milk from country to town for subsequent sale by retail it is safe to say that one hundred transmit butter, generally through the hands of middlemen, who purchase the butter at the country markets. As a majority of the original vendors of the butter are of the class who do not keep servants, in the event of sickness occurring in the family the mother would be at the same time nurse and butter-maker, and that this is constantly the case I speak from personal experience. In America, the "milk sickness" before alluded to is said to be transmissible from animal to man by means of butter as well as milk, but I am not aware of any evidence in this country

of the transmission of disease through the agency of butter. Such evidence to be satisfactory would be most difficult to obtain, but that butter is constantly made under conditions where it is brought into most undesirable contact with infection is a fact beyond dispute. As I write this I know a house where the mother of a family is nursing two children and her husband, all suffering from diphtheria, and is making butter from three cows; and I specially call to mind another case in which the brave wife of a small farmer on the Welsh border, deserted by her only female domestic, nursed solely for some weeks her husband and a resident farm servant, both suffering from severe attacks of small-pox, and made up and transmitted from a neighbouring railway station some thirty pounds of butter weekly to Birmingham throughout the whole illness. The infection had originally been imported from the neighbourhood of Birmingham, and it is not impossible that it may thus have been returned with interest. To attempt any precise regulations in the case of all houses where butter is made would be impracticable. The only solution is to aim at the total extinction of infectious fevers. If not quite practicable immediately, this is, I believe, very nearly so in rural districts. Endemic fevers should never exist. We may expect isolated outbreaks from direct importation, from recrudescence of old infection germs, and rarely, but occasionally, I think, from evolution; but epidemics should never occur. Local disseminations do occur in rural districts from incaution and indifference in visiting infected houses, or allowing infected children to mingle, or through the agency of milk or laundry work; but I believe it may be stated, with a sufficiently near approach to absolute accuracy to justify a general statement, that epidemics in rural districts are invariably the result of school dissemination. In rural districts teachers are frequently paid partly by the school fees and partly by a share of the Government grant, which depends largely upon the average attendance, and too often no excuse for non-attendance of a child through illness is held valid unless a medical certificate is

produced. It is, however, generally through cases so slight as not to have involved medical attendance that dissemination of disease occurs in national schools.

This brings us to the solution of the whole question, viz., the attaching of greater importance to all cases of infectious disease, however mild, and the appreciation of the duty of erring on the safe side in all cases of doubt. In this way only can we look for the practical extinction, at least, of epidemics in rural districts, and in no other way can we so nearly ensure that milk and milk products shall not occasionally be brought into contact with infection.

DISCUSSION.

Professor DE CHAUMONT thought they had been very fortunate in having two such able papers from gentlemen so competent to deal with the subject. The points which had been brought forward were of extreme interest to every one. With regard to the question whether milk was a vehicle for disseminating poison germs, he thought there could be no doubt that it did communicate the germs of typhoid or enteric fever, and in a smaller degree perhaps scarlet fever and diphtheria. Though this view was accepted in England, it was by no means accepted abroad, for some of his German and French friends had expressed themselves as amused with the view insisted upon by Englishmen. Some of them looked upon the whole thing more as a gigantic joke than otherwise. There could be no question that if milk was boiled it effectually prevented the transmission of disease, though he could hardly coincide with the view of Dr. Thursfield that people would get accustomed to the taste of boiled milk. He could not conceive anything more disagreeable than boiled milk ; but if he was perfectly sure that the milk supplied to him was from a diseased cow, or that it contained fever poison, he should prefer to have it always boiled rather than expose his family and himself to such a danger. Several ways in which disease could

be transmitted by milk had been pointed out by Dr. Thursfield, the most frequent, in the case of enteric fever, being by the milk being adulterated with impure water, or what was euphemistically called in the metropolis "Simpson." It had been frequently said, when trying to explain the outbreak of enteric fever occasioned through water which had been added to the milk, that the water had been merely used to wash out the cans; but this view he thought would not hold good for all cases when investigated. The other day he took part in a Milk Conference at Gloucester, and one farmer propounded a view which was very convenient from a salesman's point of view, but very alarming to the public. For he said, if we have an exceptionally rich milk from a cow, why should we be compelled to give away the cream and rob ourselves of this extra good milk which we might sell for money? This farmer considered that milk ought to be sold at a certain standard, and that if the public were supplied with milk containing so much cream it ought to be accepted without question, and that the farmers should be allowed to arrange the standard. If that were done they would take off the cream and add water, and then the public would have no guarantee that the water so added did not contain the germs of poison. As to scarlet fever, he thought it was very difficult to prove that this was propagated through the agency of water, but scarlet fever was propagated, undoubtedly, by scales from the skin; they could easily conceive, therefore, how this disease could be propagated by drinking water, by the scales in bath water getting into the supply, but it was more frequently in all probability from the hands of those who milked their cows during the stage of convalescence. That the disease was propagated from time to time unknown to the individual he knew a most recent example of. The first case was undoubtedly in a family, where nothing more severe than slight sore-throat was complained of among the children. But these children had mixed with a number of others at a drill class, and in a short time scarlet

fever showed itself in nearly all the houses in the immediate neighbourhood. In another case, an official in a large establishment was observed one day by the doctor to have something the matter with his hands, and he asked him what was wrong; he replied he had some peeling about them. On being further questioned, he admitted to slight sore-throat and a rash on the body, followed by peeling. The doctor told him he had been suffering from scarlet fever, and must go into quarantine. He had been unconscious of his condition, and had been going about at his usual work, so that it could not be wondered at that scarlet fever was propagated. As to the doubts thrown upon the propagation of disease by means of milk, there was no doubt some reason for this, for now and then it happened that milk was credited with being the cause of the disease, which upon investigation turned out not to be the case. In the barracks at Eastney, where the Royal Marine Artillery are quartered, from the time of their first occupation in 1864 down to 1878, there had never been a year without enteric fever, and in the year 1878 the outbreak was so severe, several deaths taking place, that he, in company with Dr. Macdonald, was called in to investigate it. After a short time they soon discovered that there was a sufficient cause for this in the state of the drainage, there being no ventilation at all, and as the drain ran out into the sea, it was frequently backed up by the tide, the foul air escaping into the barracks. They reported upon the cause of the disease, and in conjunction with Lieut.-Col. Crease, C.B., drew up some directions for the purpose of remedying this state of things, and putting the drains in order. However, other persons were inclined to think that this was not the true cause, as they said there was plenty of enteric fever in Southsea, and the cause was attributed to the milk. All he could say to that was that, although there had been enteric fever every year from 1864 to 1878 in those barracks, yet from 1878 down to the present time there had not been a single case, although there had been plenty in Southsea

and the neighbourhood. That proved that, although some cases might be caused by it, yet every case which occurred must not be attributed to milk, but that the cause should be traced to its true source. Pettenkofer insisted that water did not propagate disease, but this opinion was not generally shared. In India the sanitary department of the Government adopted rather a Nihilistic view: they set aside the evidence hitherto relied on as showing propagation of cholera through human intercourse, and declared that they were ignorant of the causes producing cholera. That was a perfectly philosophical position if they were unconvinced by the evidence. But they went further, and said that no one else knew, and refused to listen to anything said in that direction. That was an unphilosophical position and a serious obstruction to the progress of discovery. If it should turn out that the investigations of Koch and his friends in Calcutta had really led to the discovery of the cholera germs, which he was as yet very far from admitting, that would be a discovery lost to the British nation which they might have been reasonably expected to have made; and if such were the case he could hardly help connecting it with the unfortunate attitude of the department to which he had referred.

In the meantime those differences of opinion showed us how far we still were from a true knowledge of disease poisons, and in this matter we might apply to ourselves the comparison of Newton, that we were like children who had picked up a few bright shells on the sea-shore, whilst the great ocean of knowledge lay untravelled before us.

Mr. SHIRLEY MURPHY said it was impossible to detect the poisons in milk in such a manner as to enable the investigation to be of use in stopping an outbreak due to this cause. The only way in which it could be learnt whether milk was infected with scarlet fever, or enteric fever, was by the effect it produced upon the people who drank it. It was a most unfortunate thing that a Health Officer, who was bent on preventing disease from entering the locality over which he had jurisdiction, was unable as a

rule to take any steps to prevent infection by milk until absolutely the death returns told him that a number of people had died from the disease. This was very often the first intimation which came to him with reference to what was going on, and he pleaded very strongly that Officers of Health should be told at once, not of the death of the patient, but of the disease, so that they might have their attention directed to finding out the cause and thus prevent its continued operation. The officer might often find after a preliminary inquiry that there was a grave suspicion of the milk supply, but for some long time it was impossible for him to accumulate sufficient evidence which would enable him to say emphatically whether or not this was the true cause of the disease. The milk vendors in the metropolis were willing to give facilities to Medical Officers of Health under these circumstances, but their power was very often limited by a matter which was entirely under their control. A milk vendor might perhaps be receiving milk from five or six farms, from one of which only the infected milk came, but owing to the fact that there was no system of book-keeping, which enabled the milk of a particular farm to be traced to the customers who drank it, the whole of the farms came under suspicion, and as a result many milk vendors had stopped their business because an opportunity was not given to them, or to the medical officer, to fix upon the particular farm implicated. The whole question, so far as investigation was concerned, turned upon the system of keeping books in such a manner as to afford the means of tracing milk from a particular farm to the persons who drank it. He had spoken to more than one milk vendor as to the possibility of introducing such a system, and he was glad to say that in one large business all the difficulties had been overcome, and books were now being kept, so that if an outbreak occurred in any particular street, he could at once ascertain from what place the milk had come. As the subject of boiling milk had been mentioned, he might say his experience was that where

infected milk entered a house, the people who drank the boiled milk escaped, whereas those who drank it before it was boiled were often affected. In one house which he knew, where there were two children affected, milk was delivered, and as one of the children was delicate, the milk was boiled before it partook of it, and this child escaped, while the other one took the disease. There was no doubt a very strong presumption that boiling the milk destroyed the germs of enteric and scarlet fever, and this being so, householders ought always to boil their milk; this fact could not be too strongly pressed upon the public.

Prof. FLEMING said the subject was such a wide one, and demanded so much time for consideration, that it was impossible for any speaker to direct his attention to more than one or two points. There was no doubt whatever that diseases were conveyed through the medium of milk, but the extent to which they were conveyed, although it could only be guessed at, was nevertheless wide. They knew that diseases were conveyed from animal to animal through the medium of milk, and that there were epidemics in animals which became epidemics in man through the medium of milk. It was impossible to speak of milk without referring to flesh, and he thought it would have been as well if Dr. Thursfield had included this subject in his paper. With regard to the question of tuberculosis or phthisis, whether man derived a large percentage of phthisis from the bovine species they knew not, but they did know that tuberculosis was transmitted from animal to animal, and through the flesh of diseased animals or through the milk of diseased animals; and there was no better marked fact in the science of medicine than this. Although it could not be proved that the disease could be transmitted from bovine animals to the human species, yet he thought that the introduction of a disease from animal to animal plainly pointed to a very serious danger. He had had occasion to investigate diseases in the bovine species to some extent, and he thought there was no more serious

malady than tuberculosis. The percentage he could not even guess at, but if he said that 25 per cent. of the dairy cows were so affected, he should be very much within the mark. The disease in the cow was of a chronic nature; it was slow in its progress, and sometimes animals were seriously affected before they showed any signs of the malady. Having examined oxen after they were killed, he found serious manifestations of the disease, which before death could not be detected except by a most clever expert. The importance of this from a health point of view was very obvious, and the fact that it was easily transmissible ought to put sanitary authorities on their guard. The question of milk-sheds was also an important one, and he thought the inspection of dairies should be carried out with the greatest exactitude and care. Dairies ought to be visited regularly, and each animal should be inspected at stated intervals, in order to ascertain its health. He entirely agreed with the remarks of Dr. Thursfield as to the methods of inspection and the care which should be exercised. Sanitary science had been moving very slowly in this country, and no better evidence could be obtained of this fact than the present condition of slaughter-houses. Slaughter-houses and dairies were closely allied, as regards the public health, and the condition of slaughter-houses was to his mind a positive disgrace to civilisation. He had had occasion to visit a number of slaughter-houses, and the way in which the work was performed was positively cruel. Anything more disreputable than the state of these places could not possibly be conceived. He could not understand why in this, the richest city in the world, people should be compelled to eat the flesh of animals which had not been inspected, or which had been badly dressed. A large number of dairies were not fit habitations for cows, nor was the milk supplied by the cows fit for human consumption. If laws were introduced to enforce sanitary arrangements, and better slaughter-houses were erected, a large proportion of the diseases now suffered by mankind would be abolished.

Dr. GEORGE WILSON said it was with some considerable

amount of hesitation that he took part in the debate, as the subject had been so fully and ably dealt with by the readers of the papers and by the previous speakers. There could be no doubt, from what had already been said, that a number of serious outbreaks of disease might be traced to milk, and it was easy to undertand how such an absorbent material could take up particles of scarlatina, and that milk-pails being washed with polluted water would convey the germs of typhoid fever. But then there were outbreaks which were not fairly traceable to such causes, as, for instance, diphtheria. Some four years ago he was called upon to investigate an outbreak of this kind which took place in Rugby School. As many as ninety boys in that school were laid up with sore-throat, and some of them with serious symptoms. In making inquiries he found that the outbreak was confined to three out of the eight boarding-houses, and that these three were supplied exclusively by one milkman. Of course, that threw considerable suspicion upon the milk supply. Having made inquiries as to the families supplied in the town by this particular milkman, he discovered that a similar proportion of those families were subject to diphtheritic sore-throat, as it was called, and one of the medical gentlemen who attended some of these cases believed that the outbreak was due to atmospheric causes. and not to milk. Then came the difficult question, what was the particular polluting agent? This he could not discover. The water supply was found to be good at the four different farms from which the milkman obtained the milk; the sanitary conditions were found to be fairly good, and the only suspicious agent discovered was that the milkman admitted that at one of the farms there was a cow suffering from inflamed udder, though he said that the milk from this cow was thrown away. Of course, the outbreak was not clearly traced to the milk supply, though there was no doubt that it was due to that. He had also learnt with regard to these obscure throat outbreaks from one or two veterinary surgeons, that calves were apt sometimes to

suffer from a sore-throat which partook of a diphtheritic character, and that the calves were allowed to suckle the cows; and, as the cows were milked, he strongly suspected that several of these obscure outbreaks might be traced to that cause. Some few years ago, when investigating a limited outbreak of diphtheria, very strong suspicion was thrown upon the milk, but after excluding all other possible evidence, he came to the conclusion that it was probably due to the fact that one of the milkmen had two children in his family suffering from diphtheria; the milk was not brought to his house, but as he had himself suffered from sore-throat for several days, it was possible that, as the man milked the cow, his breath, tainted by his throat, impinged against the milk as it was flowing into the pail, and thus the disease was conveyed in that fashion. At all events, he agreed that enough had been said to prove that a rigid inspection of all dairies and milk-sheds was absolutely necessary. The Government some years ago issued an order to which Dr. Thursfield had referred, which applied to all town and country districts, that dairies and milk-sheds should be inspected, that the water supply should be good, and the drainage and other sanitary arrangements satisfactory, but the truth was that this order was in entire abeyance. The licensing of the houses and dairies had been entrusted to policemen, who were not qualified to fulfil the duty, and the order which, if faithfully and properly carried out, would have effected a large amouut of good, was now emphatically a dead letter. He was not going into the question of how this should be carried out, but he believed that sanitary officials would be the proper persons to be entrusted with the task of inspection. As to the remarks made by Professor Corfield, more especially with respect to water being an agent in the spread of enteric diseases, he confessed he formerly believed in that theory, but since he had enjoyed the opportunity of being able to make inquiries in country districts, he found that typhoid fever was often a purely filth disease. Still he had no doubt that polluted water would also cause diphtheria.

Dr. WATFORD said he could endorse all that had been said by Dr. Thursfield and Professor Corfield, as well as the remarks which had been made by Dr. Fleming as to slaughter-houses. He never sent in a report to his Sanitary Committee without touching upon the great necessity which existed for having properly arranged slaughter-houses. What he wished to touch upon was the practical results from such knowledge as had been acquired on this subject, and it was this, that they would not get on very much faster until the public, high and low, were more educated in sanitary matters. He might, perhaps, be permitted to give an instance of this. When he first took office as a medical officer of health in a town of some 17,000 inhabitants, he did so under most favourable circumstances, being ably aided and abetted by the Sanitary Committee, and having a most admirable system, by which all infectious diseases were at once notified. Scarcely anything could go on in the town without his being at once informed of it. He took office just after the town had been ravaged by an epidemic of scarlatina, and consequently, all his recommendations were readily listened to. No sooner was scarlatina introduced into the town from the adjoining districts than it was stamped out, and he began to think that they had a sanitary Utopia. However, after the lapse of a few years he found himself face to face with a danger which he little anticipated. Some years having elapsed since the outbreak, people had forgotten what scarlatina was, and upon visiting any houses where scarlatina existed, people would scarcely listen to him; one person asked him whether it was infectious; another almost laughed at him, and said she should not mind if all her seven children had scarlatina at once: it would not matter if she kept them warm. He represented to her that she would certainly have her hands full for a long time, and that perhaps one or two children might die. As it turned out, all the children did have the scarlatina, and one died, and the woman afterwards said that she wished she had listened to his advice. It was not only

the poor and the lower classes that required education, but also the upper classes. He remembered particularly one lady whose house he visited in consequence of her children having scarlatina. She said she saw the importance of sanitary measures amongst the poor in courts and alleys, but in such a house as hers, and with such a mild case, there was no necessity for precautions. He represented to her that the mildest case of scarlatina in a house containing stuffed chairs and Turkey carpets was more likely to convey the disease than in a cottage with a sanded floor. Sanitation was nothing very new. Perhaps the earliest and best medical officer of health was Moses, though the precepts he laid down were better adapted for people living in tents than in towns. Herodotus wrote that Cyrus fully understood the value of pure water, for he never drank water except from one river, and then only when it was boiled, and when going forth to battle he always took a large supply of this water which had been boiled. As the public became educated in sanitary matters he hoped they would not drive their hobbies too hard, for he thought very much harm was done by amateurs and others in this direction. He had heard it said, what did it matter? it would be all the same a hundred years hence. He hoped it would not be so. If a conference on sanitary matters was held a century hence, he hoped that a tribute would be paid to the present generation for laying a good foundation for inaugurating a better state of affairs for posterity.

Dr. PRIESTLEY said he came to that meeting rather as a learner than a speaker, but he could not refrain from saying a few words, as he took particular interest upon all questions relating to sanitary affairs, more especially with reference to the diffusion of knowledge in everything concerning sanitary reform. As a physician he was appalled at the amount of ignorance amongst those who ought to know better, and not only the ignorance but the actual indifference exhibited with reference to the spread of disease. The two principal infectious diseases which a doctor had to treat in the houses of the better class were scarlet fever and measles.

From the excellent book of his friend Dr. West it appeared that 97 per cent. of those who died from these diseases were children under ten years of age, and if this were true the question of scarlet fever and measles became so absolutely a mother's question that they ought to be so interested in it as to be able to learn how to protect their children from these dire diseases. The poison of both complaints was so subtle that medical men scarcely knew how they might be conveyed. An apt illustration seemed to be a man walking through a field when grasses and flowers were in full bloom, his clothes brushing off the pollen which he carried away with him. If a person went to a house where there was scarlet fever or small-pox, the germs might cling to him, and as soon as they found suitable soil to grow in they would do so. He thought if it were sufficiently known among women that the poisons of the diseases to which he had referred were so subtle, greater precautions would be taken to prevent their dissemination. It was well known that as soon as a woman had scarlet fever or measles in her house she became careless as to how it spread amongst others, and it was no uncommon thing for her children to be sent to the sea-side without informing the occupant of the house as to the nature the disease from which the children had just recovered, so that the rooms might be disinfected before another occupant arrived. No doubt there were great difficulties attending this matter, and in the first place it would be said that if a mother confessed her children had had scarlet fever they would not be received in the house, and consequently the difficulties of obtaining apartments would be increased. As time went on he believed this difficulty would be got over by the erection of convalescent houses where the children of the poor and rich could be properly cared for. He looked with great admiration upon the efforts which were being made in this direction. The National Health Society were working in the right direction for the diffusing of knowledge upon sanitary matters by giving lectures and publishing tracts, and he hoped that this good work would be continued.

One step in the right direction for the prevention of infection was the invention of a fever-proof dress, which could be worn in a sick room by nurses and parents so as to protect them from the infection of germs. This dress consisted of a sort of macintosh tunic which went up to the throat and down to the ground; a small cap was also provided for covering the hair, or a hood for covering the bonnet. A cotton-wool respirator worn across the mouth completed the protection. This dress had been made under Mrs. Priestley's directions. When taken off it could be thrown into a pail of disinfecting fluid. He had heard that the Asylums Board had ordered some of these dresses, so that people might be able to visit their friends who were in a dying state in the hospital, and afterwards leave the hospital without fear of carrying away the disease. Of course this dress must be used properly. It must not be thrown off in the presence of the patient, otherwise it would be like a Davy lamp, which directly the gauze was removed exposed foul air to the light. The dress must be so used that there should be no access of disease-germs to any part of the body of the person wearing the dress. Disinfection was a very important matter, and he thought every one ought to see that this was properly done before allowing a child who had had fever to go amongst the rest of the community. It was not so much the time which elapsed after the attack of measles and scarlet fever, as the question of disinfection, and he was of opinion that in these cases disinfection could be properly carried out in the space of twenty-four hours. So far as many infectious diseases were concerned, he had great hopes that the researches of Monsieur Pasteur and others would do much to help in the elucidation of the germ theory. He regretted that persons were found who opposed vaccination, and he hoped that as information upon this subject was attained, that there would be not only less opposition to vaccination, but to scientific investigation generally.

Dr. ROBERT PRINGLE said he liked the place where one could speak openly upon these subjects, and

he thanked his old brother graduate for what he had said about India, in which country he had spent some thirty years of his life. After ten years' absence from England, two things made a great impression upon him, one was the number of boys and girls wearing spectacles, and the other that in nearly every shop a glass of milk could be obtained. Some years ago he was called upon as a sanitary officer to give an opinion upon some milk, and from its odour he should have condemned it right off, but he was informed that there was nothing the matter with it. After examining it, as well as the cream, he discovered a very high aromatic odour, and upon inquiry he found that the cows had been feeding on the hill-side of the Himalayas, where they had discovered a plant very much resembling the rue. This at once accounted for the aromatic odour which he had discovered. That showed the importance of thoroughly investigating the matter. Milk was very much like a sponge: it would take up everything, and he had known milk in a very short time in India, which was absolutely pure, become absolutely offensive. With reference to the incubation of small-pox, he knew there was a theory that at the papular stage, before it reached the full mattery stage, it could be carried through given localities without imparting infection, the disease not being propagated at that time, but that the infection must either come from lymph or crust, and with this he rather agreed. As to jail fever, the only attack he ever remembered meeting was in a large jail in India, and in examining into the cause, he must have done so rather rashly, for within twelve hours he was stricken down with the fever. With reference to the chicken-pox in India, he was informed by a Medical Officer that a great deal of his vaccination had been discredited by the appearance of small-pox after successful vaccination; but upon inquiry he discovered that what was supposed to be small-pox was really a severe epidemic of chicken-pox. Upon stating this the natives would not believe him, but after pointing out the difference between the two, it was found that his diagnosis was correct. He was very much struck with the fever dress

which had been referred to, and hoped that it would be tried in fever and small-pox hospitals. In a case of small-pox which occurred in India, where the people had been vaccinated, he searched for a long time before discovering the cause, but after some time he found in the sugar some small-pox crusts, but the disease was very soon stamped out by vaccination. He was quite convinced that flies carried the disease, especially on their feet, not so much on their proboscis. In India the natives dreaded the flies for this reason. In an outbreak of cholera which occurred in India, the system of isolation was adopted most successfully. For many years he had used his utmost endeavours to procure a proper water supply in India, and after repeated efforts this had been obtained. He believed that water was one of the principal mediums for the dissemination of fever poisons, but if those who believed that such was not the case could prove it to him by a series of careful experiments, he should be willing to accept it. The importance of having pure milk could not be over-estimated, for at the present date children were entirely dependent upon it. The first point to ensure was that there was a good water supply in the dairy, and to see that there were no dead animals in the cistern, and that the cistern was perfectly clean, for he had known of an instance where the water had become putrid through the presence of seventeen dead mice.

Mr. H. E. ARMSTRONG said that in Newcastle, since 1882, a regulation compelling the notification of infectious diseases had been in force, and had been very useful in enabling him to trace disease. As to water supply, probably most medical men knew that Newcastle-on-Tyne afforded a somewhat startling illustration of how cholera could be spread by such means. It was an illustration that water companies did not draw much attention to, but it stood on record in the blue-books, that a supply and stoppage of water from a certain reservoir which was diluted with water from the Tyne was exactly coincident with the spread and cessation of cholera. The moment the supply from this source was stopped the cholera declined.

The remark of Dr. Murphy with regard to the system of book-keeping, by which in milk epidemics milk from each source might be clearly traced, struck him as being of great importance. Dr. Murphy had earned a high reputation by the way in which he had conducted an inquiry into a recent outbreak of enteric fever from milk supply, and anything he said would be listened to with great respect. Having had experience of certain epidemics connected with milk in Newcastle, he (the speaker) could endorse what had been said as to the difficulty of tracing the milk from the cow to the consumer. He thought that if this could be done a great deal of the difficulty which Medical Officers of Health had to meet would be done away with, for they would be able at once to trace the cases as readily as they could trace any other thing. He would strongly urge that a system of book-keeping—such as indicated by Dr. Murphy—should be made compulsory upon all milk-dealers. In his own district they had power to compel a list of customers, which was likely to be of service. He looked with horror upon the spread of tuberculosis by the use of milk, and he had reason to believe that it was so spread amongst children. *A propos* of the subject of meat, he thought there was an important omission in legislation, and that was that meat should be classified by the butchers. If this were done, the first-class meat would fetch a good price, and the second-class meat a lower price. The third-class should be understood to be questionable or suspicious, and, supposing any person would buy it, would bring a very low price indeed.

Dr. CHARLES WEST said he came to the meeting simply to learn, and he must confess that he had nothing new to impart, and he could do no more than enforce the wise sayings of his friend Dr. Priestley. There was one point, however, which he might refer to, and that was that he found women considered measles was such a slight thing that they said that it did not matter if all their children had it at once. Now he held it to be the duty of everyone—especially a duty to children—to do all that

was possible to shelter them from harm, and the fact that two or three children in one family had measles very slightly furnished no guarantee as to the nature of the disease, for others might have it very virulently. Although children might recover from this complaint, they often did so at a terrible cost, for measles left behind it in no rare number of instances a sort of taint in the constitution, and one not unfrequently was able to trace consumptive disease in after life to an imperfect recovery from measles. This caution he was certain was well worthy of being laid to heart. In a somewhat similar way he had observed in cases of mild scarlet fever a degree of indifference as to sheltering others, which could only arise from a misapprehension of the danger of disease, for mildness in one case is no guarantee as to what it might be in another. Dr. Priestley had spoken of the importance of persons after having had the fever not going amongst the general community before convalescence, and he must say that he thought there was a great want of proper precaution in this respect, and of disinfecting articles of clothing and bedding. When Dr. Priestley was describing the very useful dress which had been invented for nurses by Mrs. Priestley, it reminded him of what had been said by Solomon, that there was nothing new under the sun; for he recollected having seen in a book, published at the beginning of the sixteenth century, a picture of a doctor dressed in a garment which was supposed to guarantee him against contagion. This dress was made of cere-cloth, or something that had the reputation of preventing contagion to the wearer, and the doctor had a hat on his head, which formed a complete mask for the face; holes were cut in it for the eyes, the mouth being covered over by a prolonged beak. Between the hole for the mouth and this beak there was a space for aromatic herbs. The picture represented the doctor as furnished with a long wand, wherewith he was supposed to investigate the condition of the patient, and to save himself from the risk of feeling his pulse.

He quite endorsed what had been said about the necessity of educating people to understand these things.

Dr. A. ANDERSON said when he came to England his first master was Faraday, his second Siemens, the third Dr. Richardson, and the fourth was the worthy President; and he thought if those present would go and see what the latter gentleman had done at Croydon, they would find how an unhealthy place could be converted into a healthy one. Having lost a daughter from fever, he had investigated into the cause of her death, and he believed that it could be traced to milk which came from a part of the country where foot-and-mouth disease existed. Since that time he had done his best to find out when milk was infected, and to prevent contamination by such means. It was all very well to be convinced that the boiling of milk would prevent contamination, but it was quite another thing to convince women of this. If doctors could only convince ladies of this fact, one important step would have been gained.

Mr. J. CLELAND BURNS said he felt somewhat embarrassed in making any remark upon this subject, as he had hoped that there might have been present at such an important conference some gentlemen who might be able to speak with greater authority than he he could on sanitary matters in Scotland. He spoke simply as an amateur and volunteer, but with regard to those who had taken an official part in Glasgow, he could not help referring to the name of Dr. J. B. Russell, Medical Officer for Glasgow, a name well known throughout the country. Many gentlemen intimately acquainted with the details of the subject had given most valuable information, and he was glad to notice that there had been running through their remarks a vein of what was to be done in the way of legislation; and if that conference could induce the Sanitary Institute of Great Britain to try and obtain legislation upon sanitary matters, considerable good would have been derived from it. He fully shared in all that had been stated by Dr. West, having himself been subjected on three different occasions to quarantine. The

points upon which Scotland required amendments in the present Act were, firstly, compulsory notification of infectious disease; secondly, information as to the milk supply; thirdly, compulsory hospital accommodation for infectious disease in every health district; fourthly, more stringent regulations with regard to lodging-houses; and, fifthly, additional powers to Sanitary Inspectors for the summary removal of nuisances. It was only by legislation that the business of sanitation could be fully carried out. It appeared to him that at present more care was taken of the health of cattle than of human beings, and this was a thing which was much to be deplored. When the community had once been convinced that the rates and taxes would be lowered by looking after the health of the population, then, and not till then, would sanitation be properly carried out. With reference to compulsory hospital accommodation in every health district, he might be permitted to quote the remarks of Dr. Russell as to Glasgow and Lanarkshire, and he believed that his views will apply generally to the United Kingdom: "In Glasgow we have two general hospitals, supported by charity, and containing about 1000 beds between them. Only a few years ago there was but one with 600 beds. These are Glasgow institutions, and it is often forgotten that they represent all that charity has provided for a population numbering more than twice that of Glasgow. The county of Lanark has a population of 904,000, including so much of the city and suburbs as lies within it. This is a population largely engaged in the most dangerous and most exacting upon life and health of all industries—those connected with mining and iron manufacture. Yet, excepting a small hospital at Lanark, beyond the seat of these industries, there is not a bed provided for accidents or sickness except those in our two noble hospitals. If we include the population lying to the north and west, outside Lanarkshire, but neighbouring Glasgow, it is certainly within the mark to say that those 1000 hospital beds are the sole provision of charity for the wants of a million of people. I doubt

if there is in the island another million of people equally exposed to the risks of dangerous employments, and so largely belonging to the working classes, who are so poorly provided for in their sickness." In conclusion Mr. Cleland Burns hoped that this conference would lead to legislation for Scotland on the lines he had been permitted to indicate.

Dr. DUDFIELD said he agreed with the remark that the great need was for additional legislation for the protection of public health. For many years sanitarians had been engaged in the endeavour to obtain protection for the public by legislation in regard to the supply of milk, and in 1878 an Act was passed called the Contagious Diseases (Animals) Act, the 34th clause of which enabled the Privy Council to make the Dairies, Cowsheds, and Milkshops "Order," which was issued in the year 1879. It was a very useful Order as far as it went, but the misfortune was that those who had to carry it out in the country generally were persons who had no knowledge of the subject. The Order, in fact, was carried out in such a manner as to lead one to suppose that the only object the Local Authority had in view was to preserve the health of cattle, and it was a very remarkable fact that more care was taken of the health of cattle than of the health of human beings. The Government brought in a Bill last year to place the supervision of dairies, cowsheds, and milkshops under the sanitary authorities, but it did not pass; and it was probable that the Bill would not be brought in again this year, owing, as he understood, to the jealousy with which Scotch members of Parliament regarded the transfer of powers from the county authorities to the sanitary authorities. It seemed almost incredible that people so enlightened as Scotchmen were assumed to be, should oppose a measure of that kind. No doubt many evils had resulted from an impure milk supply, but there was no possibility of protecting the public by sanitary means until dairies, cowsheds, and milkshops were placed under proper supervision. Sanitary societies had been

agitating for many years in this direction, but hitherto without success. With the knowledge which at present existed upon the subject, it would be a scandal and a shame if any great length of time were allowed to elapse without legislation for the benefit of the public in regard to preventible diseases spread through the agency of milk, &c.

The DUKE OF BUCKINGHAM said he took an especial interest in these Conferences, in the hope that they might be successful in drawing public attention to the important subjects which had been discussed. By means of the papers and discussions the true facts of a great number of important sanitary questions, which pressed so much upon the attention of public men, and every person in this country, were brought forward. One of the most valuable effects of the Exhibition would be the elucidation of many sanitary matters. Sanitary legislation was no doubt a subject which every year pressed with more force upon the attention of persons in this country, and it came home to the labourer as well as to the rich man. The various alterations which had been already made, and the development of science, had brought about many improvements, but still many of these improvements had brought to their homes concurrent evils. It was those evils which they wished to reach and to eradicate. When he entered the room, a gentleman was referring to the question of the sanitary inspection of dairies in country districts, and as his experience was perhaps more of country places than of towns, he might be permitted to say that he entirely concurred in the opinion that a more general control over sanitary matters, such as had been referred to, was wanting. Those questions might have to be treated in a different mode perhaps, and considered from a somewhat different standpoint in the country, but the evils arising from insanitary conditions were as great and as terrible in their effects in country villages of half-a-dozen houses as they were in any street in this large city. He could not quite join in the regret which had been expressed that a par-

ticular measure was not carried out, because he thought that when, as doubtless would soon be the case, some measure for coping with the evils which had been referred to was brought in, that it would be founded upon a better and more sound basis than the bill which was first introduced. The object of this Conference was to consider the evils which existed, and to elucidate opinions as to the general grounds upon which they might be dealt with, and he hoped that those who attended would carry home to their neighbours and friends the remarks which had been made, in order to induce them to study the valuable information which had been given.

The CHAIRMAN said it now became his duty to sum up the discussion, and to make a few remarks upon the papers which had been submitted to them. There could be but one opinion upon the valuable points which had been brought forward in the paper which was read by Dr. Thursfield, and also in the very important communication by Dr. Corfield. The way in which those gentlemen had handled the subjects which had been placed in their hands showed the wisdom of the Committee in choosing them to bring the questions before the Conference. It could not be too frequently impressed upon the public mind, the different ways by which diseases were spread, because so long as they were absent from contact with disease itself the public mind was likely to be forgetful. The rules which had been put forward by Dr. Thursfield, and which had been insisted upon as necessary by Dr. Corfield, ought to be spread broadcast over the country, in order that the public might understand some of the dangers which arose from that intercourse which was constantly going on between unhealthy and healthy places. He would not refer in detail to the papers, but would merely take up some of the points in the discussion. The observations made by Dr. Priestley with regard to the passage of a man through a field full of flowers, and where his boots became covered with the pollen obtained from the plants, was very instructive, because, to his mind, the

majority of infectious diseases were produced by a material something allied to a plant. The way in which materials might be carried from a place where there was infectious disease and brought into contact with other material where there was not that particular disease might produce one of a different character altogether from that which had been brought, and it was possible to have those hybrids produced in disease in the same way as they were produced in plants; and even by transferring material which was not actually a part of the disease, they might have produced elsewhere a disease which was propagated from the former one. Just as gardeners, in propagating hybrid plants, knew they would be able in succession to produce a different kind, some of which had never been known before, so they from time to time might have diseases which at present were unknown. Allusion had been made to the danger arising from the fact that cows, after they had brought forth their calves, when in the condition which was called parturient, were excessively liable to suffer mischief; but it must not be forgotten that the birth of a calf, like the birth of a child, was a natural thing, and that it ought not to be so attended. In trying to make cows lead unnatural lives much of the mischief was caused, and that in a great measure was owing to the crass ignorance of those who had their management. One of the hopes of the promoters of this Congress was, that the spreading of information upon the right way to deal with this subject would help to diminish the incidence of much of the disease which was produced in animals. Dr. Fleming had alluded very forcibly to the question of tuberculosis in animals, and he knew that some years ago, when the local bench upon which he sat were asked to condemn the flesh of certain animals which had been seized by the local inspectors, that evidence was given by an inspector from Smithfield Market to the effect that 80 per cent. of the flesh there sold was subject to the same disease and infected in the same manner, and that it would be as much as their place was worth to condemn all the meat that was tuberculous. Tuberculosis

was not natural to cows, but the way in which they were treated in the cow-houses and by those who were supposed to have some knowledge of their management, had tended much to increase the disease. It was quite possible that the food of those animals might in the long run give a tendency to the production of similar diseases in the human beings who ate them. The remarks of Professor de Chaumont had brought to his mind instances where the mischief had been supposed to be traced to one cause, but afterwards it turned out that it was due to another; and the caution which he had pressed upon the meeting, that they should not at once come to a conclusion that a particular epidemic was caused by something because it seemed to point in that way, was certainly very necessary. Medical officers did not at once now jump to the conclusion that this or that condition had produced a particular epidemic, but they searched it out, and proved by the actual removal of all other circumstances that it had been caused by a particular thing. With regard to the observations of Dr. Geo. Wilson as to the possibility of typhoid having a *sua sponte* origin, he did not think that diseases such as small-pox and diphtheria ever arose *sua sponte*, but that they were always preceded by germs from a similar case, and it was a question whether there were not conditions in connection with the filth arising from the aggregate of human beings which would produce or allow the germs of typhoid to develop anywhere. If he took a piece of bread and put it into a dark cupboard which was rather damp, in the course of a little time it would be covered with mould. Penicilium was to be found everywhere, and the probability was that the excreta from human beings, whether from the skin or the breath, or any mucous membrane, if allowed to get into drinking-water would produce typhoid. First of all it caused irritation of the bowels, and after a time increased in intensity. It might be perfectly possible for an individual to infect himself, but this was not true with regard to a number of other diseases. With regard to small-pox there must be a germ from a preceding case to have it produced,

then came the question how the first case of small-pox arose. He did not quite see how that came about, except on the principle which had been mentioned, as belonging to the *rôle* of the gardener, that by crossing different plants he obtained different productions, and it was quite possible that diseases originally had been propagated from one kind to another in that way. The suppression of disease was an important point, for it showed how difficult it was to get knowledge spread abroad amongst those who had to do with its repression. When the Contagious Diseases Act (Animals) was passed, he was appointed one of the members of the local authority in his own county for the purpose of getting those diseases controlled, and he knew that a great deal more trouble was taken to repress disease amongst animals than for the purpose of repressing it amongst men. He had always impressed upon the authorities with whom he came in contact the extreme importance, in carrying out the Act, of it being placed in the hands of the sanitary authority of the district. The advice was not followed. When the Committee was first formed, he brought to its notice the absolute uselessness of many of the arrangements, whilst they allowed stock-keepers and others connected with the management of cattle to go about with their dirty boots and clothes, and even their persons covered with the saliva of diseased animals, without being disinfected; representations were made by his Committee to the Privy Council at the time upon this subject. Only a few days ago an order had been issued by the Privy Council giving the local authorities power to make bye-laws as to the disinfection of the clothes of persons who came in contact with animals infected with foot-and-mouth disease. That was a very important regulation, and the local authorities, by pressing this as they ought to do upon the attention of their inspectors and the police officers, who unfortunately had the carrying out of the regulations in the rural districts, would help to educate the people as to the danger of allowing intercourse between individuals in houses infected with the

diseases to which reference had to-day been made, and outside people. Mr. Burns had spoken of the necessity of legislation, but he thought there were two sides to that question. There should be legislation for those who were unable to protect themselves, and who were placed in conditions where they were quite unable to be protected except by legislative enactment, from the ignorance and wrong-doing of others, but he was adverse to calling on Parliament to legislate for them on every possible occasion and on all kinds of subjects. The public ought themselves to take these matters in hand, and, whilst he approved of general principles being passed by the House of Commons as general principles, he was very much averse to details being brought into Acts of Parliament.

Upon the proposition of Professor DE CHAUMONT, a cordial vote of thanks to the Chairman for presiding was passed, and the Conference adjourned.

Conference on Friday, June 13, 1884.

1. "*The Right of the State to Enforce Notification of Infectious Disease, and the Best Method of Doing It.*" By Alfred Carpenter, M.D., J.P.
2. "*The Notification of Infectious Disease: its Importance and its Difficulties.*" By Alfred Hill, M.D.

Chairman:

The Right Hon. Earl Fortescue,

*Vice-President of the Parkes Museum of Hygiene.**

The Chairman said that he concluded he owed the position which he had the honour to occupy there to the hard labour, and, he might add, the sufferings he had undergone in the cause of sanitary reform. It would be impossible for him now to work as he had done formerly, owing to advancing years, but he was present that day to testify his unabated attachment to the great cause of sanitary reform, and his strengthened instead of impaired conviction of its important bearing, not only upon the physical but the moral and, he might add, the religious condition of the population. In the wide-spread work of sani-

* The Presidency vacated by the lamented death of H.R.H. the late Duke of Albany has not been refilled.

tation it must be inevitable that individual liberty and the rights of property must to a certain extent be interfered with for the public good. He should listen attentively to the arguments for and against a novel but by no means unprecedented extension of that interference in the shape of compulsory notification of the existence of infectious diseases which would be proposed. He would say no more than that it was for the advocates of any compulsory interference with individual liberty or with the rights of property to justify exceptional legislation for that purpose. Liberty itself was so very precious a possession that it ought not lightly to be curtailed, and confidence in the security of property was so indispensable to the development of self-denying thrift and industry and the retention of capital that it ought not lightly to be shaken or alarmed. It was better to tolerate a certain amount of inconvenience, of evil, and even of suffering, rather than lightly to interfere by legislation with liberty and property. Capital might really be described as the wage fund which was liable to be scared away on the slightest cause of alarm. Not only would alarm about any one kind of property decrease confidence about the rest, but it scared away any capital which might be inclined to come into the country. Nay, more: as many kinds of capital were easy of transport, any alarms tended to scare it away from the country in which it was, to others offering a better prospect of security. The infringement of liberty was attended with much more serious evils. The too constant official interference certainly tended to enervate the national character, and to render men helpless and unfit for liberty after they had been too long looked after and done for, incapacitating them for the duties and responsibilities of free men. Moreover, the evil of enlisting general sympathy against the law by any prematurely stringent enactment and enforcement of regulations, tended to diminish sympathy for, and support of, the law generally; it caused the law to be looked at, not as it had always been in England, as the general friend and protector, but rather either as an unpopular King Stork, or, if the enforcement of a

public law was neglected, as a King Log, which was an undesirable aspect for the law to be regarded in. Multiplied official interferences required multiplied officials, and multiplied offices to be filled were accompanied by an even disproportionate multiplication of office-seekers ; and though competitive examination tended to diminish the number, and to eliminate those least qualified intellectually for offices, yet the training for those examinations was a preparation rather for the work, to speak in the language of political economy, of verification or distribution, than of production. In these days, when there was a general complaint of slackness of business and want of prosperity in mining, in agriculture, in manufactures and commerce, he dreaded anything which tended to augment the body of distributors of a diminished produce, and the unofficial verifiers of a diminished number of transactions. In spite of the judicious establishment of competitive examinations a very large proportion of official patronage would inevitably fall into official hands, and in a country with a party government like ours it must fall into political hands, and much of it was likely to be given away for political services. The tendency when new offices were created was generally in the first appointment to seek the fittest man for the place ; but after a vacancy or two the other aspect of the question predominated, and the disposer of patronage was apt to be more earnest in seeking out *a* place for *the* man, and so they found that after offices had been created and had existed for a certain time there was a tendency to diminished zeal and qualifications in those who were after a time appointed to them. Having been for more than forty-five years connected with public life, some of it with paid and unpaid offices, and almost the whole of it with one or other of the Houses of Parliament, his experience led him to believe that the proportion of appointments of ill-qualified, undesirable candidates, was not so very different between one government and another, and was not generally found at all better in governments with ministers who made extravagant professions of purity. He should listen to

the various speakers with a mind quite open to conviction, but with the leaning indicated in these remarks.

Before concluding, he might suggest that the various speakers should confine their remarks to the following points: first, What success had attended the system in regard to the number of cases notified to the total number of cases? secondly, What success in stamping out diseases it had led to, or rather, whether there had been any diminution in the spread of such diseases? and, thirdly, What amount of hospital accommodation the sanitary authorities of the place had provided for infectious diseases, and to what extent it had been made use of?

THE RIGHT OF THE STATE TO ENFORCE NOTIFICATION OF INFECTIOUS DISEASE, AND THE BEST METHOD OF DOING IT.

By ALFRED CARPENTER, M.D., J.P.

THE early discovery of infectious diseases to a local authority, like to the early notification of a fire at a fire station, is one of the subjects which engaged the attention of sanitary reformers as soon as the dogma of destiny was seen to be fallacious by those engaged in the struggle with death produced by preventible causes.

A proverbial philosopher has written that "If pestilence stalks through the land, ye say, this is God's doing," and then he proceeds to combat that idea. I will not follow his example, for I contend that it is God's doing, inasmuch as it follows upon a neglect of His beneficial laws, and a disobedience to His commands as to purity and cleanliness. It is in consequence of such neglect that disease stalks through the land, and I may say with the same philosopher that "Verily there is nothing so true but the damps of

error have not warped it, and there is nothing so false that a sparkle of truth is not in it."

Without, however, going into first causes, and supporting as I do in the main the observations of my friend Dr. Hill as to the necessity for early discovery, I wish to point out some of the difficulties which are in the way of doing it as is suggested by some earnest sanitarians, and at the same time to give a short history of the progress which has been made in that direction. I agree fully with the proverbial statement that "a spark is a molecule of matter which may kindle a world," and I opine that the great object of the sanitary world is to get evidence of the presence of that spark before it has time to reproduce its kind, and that the machinery which will give the most complete and general result in practice will be more satisfactory than one which may be perfect in theory but for various reasons not so efficient in action. The first good experiment as to method came from Manchester.* The Manchester Sanitary Association did that nearly twenty years ago, which the Society of the Medical Officers of Health suggested as the right thing, but failed to do it for want of funds, the Government of the day refusing to help them in their proposals. The Manchester Association published a weekly return of all new cases of diseases coming under treatment at the various medical institutions in Manchester and Salford. The sanitary section of the International Statistical Congress held in the preceding year had considered the subject and had pointed out the method of doing it. The Congress had urged it as a duty upon governments to get the information in the usual way, and pointed out that a knowledge as to the position of the onset of disease was of more importance than were the returns of actual mortality, a principle which I had inculcated at various local meetings held for sanitary purposes, long before the Congress alluded to. The Manchester returns gave timely warning of the foci from whence

* I am informed that similar returns have existed in Marylebone from about the same time.

it might be expected that infectious diseases would spread as spread they did. Manchester, without Government assistance, did that which London was unable to do. Attempts were soon made in different parts of the kingdom to provide similar returns, but they were only "flashes in the pan," and were not persistent. The late Dr. Lankester brought the matter to the notice of the Social Science Association on June 5th, 1871, at their rooms in the Adelphi; Dr. W. Farr being the Chairman at that meeting. Dr. Lankester urged that the State should stand in *loco parentis* as regards those children who were not vaccinated, and that a Court of summary jurisdiction should have them vaccinated in spite of the parents, and that heavy fines should be inflicted upon all medical men who attended cases of small-pox, who did not at once notify to the local authority the fact of its presence at that particular place. This was the first suggestion made in a general meeting in this country, that a penalty should be put upon a medical man for not notifying to the local authority the fact of the fire, although it had been previously suggested that the local authority ought to be fined for allowing the fire to extend itself. I had urged this view because the foci of disease could not become persistent if the local authority did its duty, and insisted upon local cleanliness, with the generous distribution of a pure water supply.

The subject of notification of small-pox, upon the motion of the late Dr. Patrick Stewart, was referred to the Committee of the Health Department of the Social Science Association to consider and report upon, as to what steps could be taken to effect the desirable object of stamping it out. It was discussed and re-discussed at the Congresses of that Association without any satisfactory result. At Brighton, in 1875, it was resolved to recommend the Council to take into consideration the desirability of promoting by legislative enactment that all cases of an infectious character should be reported to the Medical Officer of Health of the district, but, to meet objections made in the meeting, the reporter was not distinguished.

Dr. Littlejohn is said at that meeting to have strongly opposed the resolution as it stood when first considered, viz. "that it should compel medical men to report." He said veterinary surgeons were not called upon to send certificates under the Contagious Diseases (Animals) Act to the county authority, and he considered that it would be "invidious and monstrous to throw such a responsibility upon medical men, instead of casting it upon the man of the house where the case took place."

In the same year, 1875, the North-Western Association of Medical Officers of Health memorialised the President of the Local Government Board in favour of putting medical men in a criminal position if they did not report to the local authority any case they might be called upon to attend. The subject was again publicly discussed in London on April 29th, 1876, when, at the request of the Health Committee of the Social Science Association I read a Paper upon the right of the State to obtain early information of the appearance of epidemic or infectious disease in a given district. I discussed whether the medical attendant ought to be the informant or not. In that Paper I dealt with the subject from its various aspects, *pro* and *con*. A very careful consideration led me to conclude that there were even more than two sides to the question under consideration, and that it was not so absolutely one-sided as the Social Science Association and Northern Medical Officers of Health Society at their various meetings seemed to think. The Chairman (Dr. W. B. Richardson) in summing up, said that in the discussion four distinct views had been enunciated.

1. That the duty should be absolute upon the medical attendant under a penalty for neglect.

2. It should be upon the legal representatives, as head of the family or of the household in which the case occurred.

3. That there should be a dual notification, that is notification by both parties. Whilst the 4th made it the duty of the medical attendant to inform the head of the household in writing as to the infectious character of the disease.

which information the householder should be bound, under a penalty, to transmit to the local authority.

Each project had been supported in the discussion by about an equal number of speakers. The last view was the system advocated in my Paper, and is the plan which, to my mind, was most likely to effect the object we all had in view.

The divided counsels at Adam Street did not get the matter settled.

It was again taken up by the Society of Medical Officers of Health, and at a meeting held December 15th, in the same year, certain resolutions were proposed; and, after several suggestions and amendments had been made, it was unanimously resolved that—

(1) Infectious disease ought to be reported by the householder to the sanitary authority without delay.

(2) Every medical man attending a case of infectious disease should give immediate information respecting its nature to the occupier or other person responsible for reporting to the sanitary authority.

It does not appear from the report of the discussion at that meeting, which was presided over by Dr. Buchanan, that any proposal was made that medical men should be subject to a criminal prosecution if they did not disclose the nature of the disease to the householder; much less suggest that they should be criminally prosecuted if they did not do so to the local authority. The Chairman in summing up the discussion said he thought it the duty of the society to affirm the principle without, however, making it compulsory under penalty upon the medical profession to give the sought-for information. He (Dr. Buchanan) felt persuaded that as soon as the profession found itself morally bound to do a thing, there would be no ground for suspecting any evasion of the duty, even although there was no legal compulsion. The Parliamentary Session of 1876 witnessed the introduction of clauses in local Acts giving the power to the local authority of prosecuting medical men who did not notify the existence of such disease to

the local authority. Huddersfield introduced such a clause, which inflicted a penalty not exceeding £10, but which was partial in its application. The subject was handled in a masterly manner at the annual meeting of the Social Science Association at Liverpool in 1876 by Dr. Francis Bond, who argued in favour of the householder being the informant under a penalty, and that medical men should make the communication to him as a moral duty.

In the following year the Town Council of Coventry passed resolutions having the same effect as indicated in the course which Dr. Bond had suggested at Liverpool, and Dr. Ransome urged the same course as essentially necessary in a Paper which he read to the National Health Society in May, 1877.

About the same time the North-Western Association of the Medical Officers of Health again approached the President of the Local Government Board, but this time they suggested that the householder should be the informant, and that the medical attendant should be liable to a penalty if he did not disclose the nature of the case to the householder or person responsible for the care of the patient. Memorials were also sent to Mr. Sclater Booth by various sanitary authorities calling upon him to introduce a measure into Parliament for the purpose of effecting legislation in the direction thus indicated.

A further step was also taken by the town of Bolton, which obtained a clause in an Act of Parliament putting a penalty for non-disclosure upon both householder and doctor, the doctor being liable to a penalty not exceeding £10, but entitled to a fee of *2s. 6d.* for notifying.

A temperate and well-written Paper on the subject was read at York in July, 1878, by Mr. North, to a combined meeting of Medical Officers of Health for the Northern, Western, and York Societies, in which the difficulties to be encountered by compulsory notification were placed before the members. It did not convince the various Medical Officers of Health assembled at that meeting. They found themselves

so often foiled in their endeavours to arrest disease because foci had been conveyed to many places before information reached them as to its existence that they still insisted upon going to the fountain-head for the information, in all those cases at least which came to the cognizance of the members of the medical profession. The advantage and saving of trouble by this course to medical officers cannot be doubted, and if all cases of infectious disease were attended by medical men as a matter of course, it would, if carried out efficiently, do what the medical officers require: viz., give them intelligence as to the whereabouts of dangerous infection. But no one can read the reports of the medical officers of health from all parts of the kingdom without coming to the conclusion that the greatest spread of infection is brought about by those cases which are not under orthodox medical care at all, and that notification by the medical profession alone would not effect the object, but rather lead to ignorant attempts to smother up the evidence, and in the end to raise up more persistent, and more wide-spread, outbursts. There was a necessity in the minds of medical officers of health for dual notification; and all the local Bills introduced into the House of Commons in this and succeeding years contained clauses requiring the medical attendant, either with or without the householder, to notify to the local authority under penalties.

I now refer to the action of the British Medical Association. The first note was sounded by that body soon after Dr. Ransome had moved in the matter at Manchester, for he introduced the subject to the notice of the Association at Leamington in 1865, and procured the appointment of a committee to consider the registration of disease. Various reports were made by that committee, and in 1875 it was stated that the authoritative declaration of the nature of the disease must come in the first instance from the medical attendant; but the committee also expressed their opinion that the proper individual to make the return would, in the first instance, be the householder, or the person in charge of the case. I had dealt with the

matter in this direction in the address upon Public Medicine which I had the honour to read at Sheffield in that year. The subject was then referred to the Parliamentary Bills Committee, in whose charge it has since been. Voluminous reports have been presented from time to time, and accepted by the Association, and the moral duty of communicating that information to the householder has been often insisted upon and agreed to. The report of the chairman of the committee upon the subject is a masterly *résumé* of the action of the committee, and should be studied by all who take interest in the matter. A discussion took place at Ryde in 1881, when Mr. Michael, Q.C., proposed an amendment to the report, which amendment cast the duty on the medical attendant, and made its neglect a penal act, but which was lost by a large majority.

At Worcester, in 1882, the subject was brought prominently forward both in the Public Health Section, of which I was President, and in the General Meeting. The result of the discussion which ensued was the overwhelming defeat of Mr. Hastings' resolution, which made neglect to report a penal act, and the following proposal was adopted: "That, whilst desiring compulsory notification of infectious diseases, the Association wishes to express its opinion that the compulsion to notify should be placed upon the householder as his duty as a citizen, and not upon the doctor."

The subject continued to be debated in various quarters, and on April 26th, 1881, a deputation waited upon the President of the Local Government Board, which was formed by representatives of various societies, to ask the Government to legislate upon this and other subjects connected with measures necessary to guard the public health from the danger of infectious diseases.

One of the sequences of that deputation was the appointment of the "Hospitals Commission" to inquire respecting small-pox and fever hospitals; the extent and sufficiency of hospital accommodation, and, with other matters, "to ensure as far as practicable the protection of the public against contagion." The report of the

Commissioners states very distinctly that "notification should in all cases be obligatory upon one or more of the following persons: the patient; those in charge of him; the occupier of the house in which he lodges; his medical attendant, or any relieving officer (if a pauper) to whom he may apply for assistance." In effect the report says it is only by the medical attendant (if any) that the disease can be intelligently notified, since it is only he who can be presumed to know what it is, and who has no interest in concealing it; but it is represented that to impose that duty upon him directly and undeservedly would interfere with the relation which ought to exist between him and his patient, and might prevent the aid of a medical attendant being sought for at all. If this be so it may be sufficient that the medical attendant should be required by law to furnish to persons in charge of a patient, or the owner or occupier of the house in which he lodges, a certificate of the nature of the disease, stating whether proper isolation can or cannot be secured without removal, and, when removal is necessary, stating also to what extent the case is urgent or severe. "The persons to whom this certificate is given should be in like manner required by law to forward it at once to the Medical Officer of Health."

Evidence upon these points were obtained from various societies, such as the Medical Officers of Health, the Sanitary Institute of Great Britain, as well as the numerous witnesses who had personal knowledge of the behaviour of small-pox and other infectious diseases.

I now come to the last phases of this important matter; Mr. Hastings introduced a Bill into the House of Commons for the purpose of putting a private medical man into the position of a criminal if he did not become a state official, whenever he came into contact with infectious disease, whether he was willing to be a state official or not. The Bill came on for second reading on June 27th in last year. The House was counted out immediately after Mr. Hastings' speech in its favour, and the Bill was not proceeded with. The Government had been previously interviewed by

Mr. Hastings' followers, but they would not pledge themselves to support a general Act, although pressed to do so by some men who are notably anxious to make the medical profession occupy a secondary position in the country. In October of last year the Social Science Congress held its meeting at Huddersfield. It might have been supposed that after the defeat of the President of their Council on this matter, that as Huddersfield was the first town which obtained the advantages or disadvantages which attach to a penal clause, and is the town in which compulsory notification has been the longest in operation, we should have had a convincing discussion as to the benefits or injury which had resulted to the town from the passing of the Act. It does not appear that a single word was said upon the subject by either side. Mr. Hastings did not raise the point, and no other person said a word about it; and although the Social Science Association had been on former occasions so very positive about its benefits, and were actually meeting soon after their President's defeat, in the very town most capable of producing convincing proofs, if they were forthcoming, as to the advantages of the Act; there was a silence on the subject which to me is inexplicable unless on the view that the results do not correspond with the prognostications, and that it would have not been safe to excite a discussion among those capable of proving the negative.

If towns having the compulsory clauses in operation are not able to show better things than can be shown in those places in which only a moral obligation to disclose exists, I think it must be evident to those who wish to prevent us trusting too much to a paternal Government that we had better steer clear of too much compulsion, and trust a little more to moral obligations. There is a strong feeling in the commercial world against professional men, such as lawyers, commission agents, auctioneers or engineers, accepting a commission from both sides in a given case, and being engaged as advisers for both sides in any com-

mercial transaction; and I fail to see any difference in the case of a man who is employed by a private and responsible individual to cure him of his disease being compelled to accept a fee for disclosing something which may be used by the local authority to the injury of his client and employer.

The object of notification is not simply a registration, but a repression of disease; and if the repression is brought about; the means whereby the repression is produced is of no consequence. If the fire is put out, it would be curious indeed if the local authorities complained, or asked for the infliction of a penalty upon the person at whose house the fire occurred, because they had not been informed of the fact by the man who had put out the fire, whilst it is certain that when rewards were offered for the discovery of fires, much false information was forthcoming at the fire station. There would be reason in the application, if the fire had not been put out, and several other premises had also been consumed in the conflagration. It might be reasonable to ask for it, but here again there might be a difficulty if it could not be proved as to the nature of the case, and in which house the fire first appeared. I am curious to know how many certificates have been sent in, reporting cases which turned out after all to be false alarms instead of true reports. If you look into the evidence given to the "Hospitals Commission," it will be seen that it was not always clear that a given case was small-pox, or typhus, or scarlatina, or even infectious disease at all.

In some cases it might be important that the medical attendant should be put into the witness-box, as against the householder, but if he is made a *particeps criminis*, his mouth is closed as regards the prosecution; he cannot be called by the local authority, he cannot be made to convict himself; whilst if he has not informed his employer as to the nature of the disease (as it is possible to be alleged by that householder in his defence), he would be guilty of a moral wrong which if proved against him would be of much more serious consequence to him than any money penalty, which penalty if inflicted would be certain to

be paid by his employer as part of the price of his silence, and as payment for the prosecution which had been instituted against him. If an employer is determined to break the law, and his medical attendant will acknowledge to having committed a moral wrong for the purpose of assisting in the fraud, the same attendant will not disclose, if the employer agrees to hold him pecuniarily harmless. The evil will be as great in the one case as in the other. Whilst the medical attendant cannot be called for the prosecution, he will be able to appear as a witness for the other side, and, if he likes to say so, can aver that the prosecution is mistaken as to the identity of the case. To my mind it is far better that the local authority should have the moral support of the medical profession than run the risk of having a "*non omnia possumus*" set up by the passive action of a large section of the medical profession in a given town, whilst the fear that the medical attendant is bound to directly disclose could not be used as an argument against the employment of an orthodox medical man. If such a man be employed to treat infectious disease, and if the householder does not disclose it, it will be ten times over more to his interest to prevent the spread of the disease which he is hiding up, and in his own interests, as well as for his medical attendant's sake, to use the most persistent endeavour to extinguish the disease, and prevent any knowledge of it reaching the ears of the local authority in consequence of that extension.

A disagreeable medical officer of health, or the fussy and interfering action of an acknowledged rival, the impropriety and the public scandal of one medical man taking legal proceedings against another, and that other possibly his superior in social position and in professional standing, ought not to be countenanced by medical men at any rate. However satisfactory it might be to some others that such proceedings should be taken, there will always be in every profession some men who will see in the opportunity of throwing dirt at a professional superior the possibility that

some of it will stick; and all men are not able to see the motive for the malicious action.

Until all medical officers of health consist of either consulting practitioners or men who are not in practice at all, there certainly will be some who will be able to hide for a time the malicious character of their action, and try to injure another man's reputation for the purpose of establishing their own, not seeing that, if their own is not capable of being established without the other man is damaged, they are proving their own littleness, and their own incapacity to excel their neighbour in the estimation of the people simply by professional work. I am very much opposed to placing any such power in the hands of professional rivals. The method by which action may be taken is so likely to be moved by motives out of sight; men will so often try to pose as energetic and self-denying officers, and be but too often able to inflict undeserved damage upon a rival practitioner before the real motive is seen, that I for one set my face against the new departure which is being made in this direction; and I aver that we do not want too much of compulsion in our sanitary work. It does not follow that a despotic government will always be benevolent. It is found by experience that as good results have been obtained in districts in which notification is voluntary as in those places in which it is compulsory; indeed the incidence of infective disease is higher in Huddersfield, in Bolton, in Edinburgh, and in Dundee, than it is in a number of places in which there is no compulsion upon medical men, showing at once that compulsion has not extinguished the diseases which are proposed to be stamped out by it. If those towns could show that the disease had been completely arrested by the power they possess, there would be grounds for argument in favour of the extension of compulsory notification to other places, but whilst the cases continue to be nearly, if not quite as numerous, whilst the mortality continues to be considerable, it is evident that there is much more to be done by the local authority in removal of the causes which

promote the spread of infection, than simply by enforcing professional notification; and whilst ready to concede that the householder ought to notify as a part of his duty as a citizen of a civilised country, I think it would be much more likely to bring the whole force of the profession to bear upon the subject if it was insisted upon as a moral duty to the state, that a written notice should be given by the medical man to the householder *as a part of his prescription.* I would rather that the neglect to perform a moral duty should be dealt with by the medical licensing authorities or by the Medical Council than it should be made a penal matter to be dealt with in a court of summary jurisdiction by those who will not always be able to see the motive for the prosecution or the medical bearing of the case, and the possible differences of opinion which will sometimes arise, and which will be best dealt with by men of high standing in the medical profession. Let us try to get a general Act which shall apply the same law as to infectious disease as does now apply to contagious diseases among animals. Let us see the result of the general application of such a law, and if after a time it is found to fail in its effect there will then be a sufficient reason for placing penalties upon a whole profession for not performing that which can only be regarded in the light of a moral duty. To place a power of prosecution, even under such circumstances, in the hands of a fellow-practitioner would be wrong, and I should urge that in such a case a prosecution should only be instituted with the consent and by the action of the Medical Council of Great Britain, so as to get rid of the possibility of professional rivalry, and vindictive or malicious action on the part of a professional brother. I am bound to say that the Medical Officers of Health have not used the power they possess, against their professional brethren, in the thirty-five towns which have now a compulsory clause, and it is much to their credit that penal proceedings have not been taken by them; but they have also to show that if it were penal on the householder only, as a

citizen of the commonwealth, it would not have been so effectual as they say it has been. I think it would have been equally so, and that the same results would have been obtained in the one case as it is assumed to have been obtained with the dual notification. The fear which does arise among the people that medical men will be informers against the patient's interest could not have any foundation, and we should not find so many cases reported which have not been recognised by an orthodox practitioner, because they have not been placed under any medical man's care.

It has been argued that, as medical men are bound to give certain information as to births and deaths, they should be also bound to do the same as to infectious diseases. Those who argue in this fashion in support of dual notification are not acquainted with the actual state of the law. The fact of a birth or a death does not come to the knowledge of the authorities through the action of the medical attendant. He is bound to give the certificate of death to some person required by the Act to give information, precisely as some of us support, as the right method of doing it, in registration of infectious diseases. The Registrar-General seldom or never has reason to put the penal clause in operation, and if he did it would not have the invidious effect as if put in force by a rival practitioner.

At the time when I read my paper at the invitation of the Social Science Association, viz., in 1876, a communication was read from Dr. L. J. Egeling, a distinguished sanitarian at The Hague, which indicated the law as recently enacted in Holland. That communication will be found in the transactions of the Social Science Association. The effect of that letter upon the meeting was manifest, and inclined several of those present to the necessity of dual notification. It being my desire to get the best information possible upon the working of the Act, I wrote to Dr. Egeling, and put certain queries to him which he has been kind enough to answer,

and which I now submit, as in duty bound, for the consideration of the Conference. I think they bear out in a great measure the conclusions I have come to regarding our position as a profession. (*Vide* Appendix, page 256.)

THE NOTIFICATION OF INFECTIOUS DISEASE: ITS IMPORTANCE AND ITS DIFFICULTIES.

By ALFRED HILL, M.D.

WHETHER Lord Bacon did or did not say that "knowledge is power" matters little, compared with the importance of the truth expressed in the dictum. Without a knowledge of the causes, symptoms, and treatment of a disease, we should possess very little power to alleviate or cure it; but without a knowledge of its existence, none at all.

In order to prevent the spread of disease, and the possibility of one or two cases developing into a widespread and fatal epidemic, a knowledge of the existence of first cases is indispensable. The importance of this knowledge, I presume, will be almost universally admitted. There is only one way of obtaining such knowledge, and that is by means of notification, the imparting of it or making it known to the proper person or authority.

Leaving out the small section who deny the desirability of notification at all as too insignificant in number to demand attention, there are two classes of those who agree that notification is desirable, who stand in opposition to each other as to the question, On whom should the duty of notifying devolve? This question is one not so much exercising the mind of the general public as that of the members of the medical profession, but it is one upon which, on this account, it is very desirable there should be as nearly as possible unanimity of opinion and action among medical men, as it is with them and them alone

that primarily the duty of notification of some kind must rest, and without whose co-operation any notification of a thoroughly efficient kind is impossible. There is a difficulty, however, in obtaining this unanimity; and while one section of the profession fully admits the importance and necessity of notification, and is willing to carry it out, another and, I believe, a smaller and still diminishing one, strenuously resists all attempts to impose the duty upon them, maintaining that it should be imposed solely on the householder or guardian. At first sight there is a certain amount of reasonableness in this view of the case, but even this disappears when its advocates proceed to argue that where notification is in operation it has had the effect of doing harm rather than good. If this is their opinion, instead of declaring that they are in favour of early notification as an abstract proposition, they should, to be logical, declare themselves opposed to it, unless they are prepared to prove that notification by the householder is beneficial, while by medical men it is injurious.

I propose here to consider the alleged objections to compulsory notification by the medical attendant, as it is these which constitute the chief obstacles or difficulties with which notification has to contend.

The first of these is the compulsory character of the duty —the compulsion pure and simple, no objection being made to the proposal to put compulsion on the householder or guardian, though I fail to see that compulsion as such need be considered more objectionable by a professional than by a non-professional informant. It is, however, said to be derogatory to a medical man's dignity and self-respect to be so compelled. But wherever a duty of great importance to the general welfare has to be performed, the only way to ensure its performance is to make it compulsory; to make the Act simply permissive would inevitably mean failure from non-compliance on the part of some, where it is essential that compliance should be made by all. It is rather late in the day for medical men to display such extreme sensitiveness on this point, and to treat it as

though it were a new principle and practice. They are accustomed to notify under compulsion the deaths of persons whom they have attended; and although it is true that when this measure was originally proposed it met with similar opposition to that now exhibited to the notification of disease, it became law; and while it proves a great public advantage, it is found to be in no way detrimental to the interests of the medical man, or hurtful to his *amour propre*. Compulsion again is seen in the laws in respect of registration of medical men, and of their services as scientific witnesses, in respect of the sale of poisons, and more heavily still with regard to the provisions for the practice of vivisection. Under these circumstances it seems difficult to understand why, when another service inseparably connected with professional duty, and inferior to none of the others in importance, is required in the interests of public health, there should be such a violent opposition to its imposition. It seems to me that the dignity of medical men, instead of being injured by the performance of the duty required, would be greatly magnified and enhanced. All law is associated with compulsion, which is as indispensable to control the action of non-medical men as of medical. This is seen in the registration of births, vaccination, education, regulation of hours of labour in mills, manufactories, and other places, service on juries, and numerous other matters, and it is only because it is impossible to accomplish the object in view by voluntary action that penalties become necessary. It has been urged by one opponent of compulsory notification that the voluntary principle is the true one, that it has been known to succeed, and he does not see why it should not be adopted everywhere. There is a simplicity about this view which renders any serious consideration of it unnecessary.

No one will deny, I presume, the value for various purposes of the certification by the medical man of cases after death, but it is of little use as regards the prevention of disease, because it comes too late; notification seeks to remedy this defect by giving to the sanitary authority the

earliest information possible of the case, by which not only may the best be done for it in the way of removing causes, and rendering assistance in various ways so as probably to prevent a fatal termination, but also to prevent the spread of the disease to other members of the household and to neighbours. The causes of the disease are often not inquired into by the medical attendant, who is apt to regard his duties more as curative than preventive; it is seldom that he makes a searching examination of a house with the view of discovering sanitary defects, whereas the duty of a medical officer of health is not to meddle in any way with a patient, but to seek for any existing defect in the sanitary arrangements of the dwelling. Let us take a common case; a member of a family may be suffering from diphtheria or typhoid fever, which the medical attendant may skilfully diagnose and treat, but he may content himself with some general inquiry as to the sanitary condition of the house and its surroundings without making a rigorous investigation; the cause of the illness may be probably a sink or cellar drain in direct communication with the sewer, or it may be a faulty water-closet, leaky soil-pipe, a polluted well or some similar defect, discoverable only by such an investigation as would be made by the medical officer of health. If this exciting cause of the illness be allowed to remain during the illness there is little likelihood that the patient will recover, but if speedily removed the probabilities of recovery are immensely enhanced, "*causâ sublatâ tollitur effectus.*" So that not only is the recovery of the patient rendered more likely, but the dangers of the spread of the disease are likewise diminished. This illustration will serve to indicate the value of early notification, and one of the directions in which it is calculated to be of advantage.

The objection to voluntary notification is that it is incomplete and, as human nature is constituted, probably ever must be, but unless complete it is useless for the prevention of epidemics; it is only because of its incompleteness and, therefore, uselessness under the voluntary system, that it is

necessary to resort to compulsion. The value of complete notification was well seen in Birmingham during the early days of the present visitation of small-pox. This disease is one which from its rarity and from the dread of it in the minds of the public is more likely to be spontaneously notified than any other ordinary zymotic; the consequence was that for many months the disease could get no footing in the town, because under the influence of fear every case was notified to me directly on its nature being made out; over many months 77 sporadic cases were reported, with the result that the disease was prevented spreading by means of isolation, disinfection, &c.; but in time cases occurred which were not reported, and then the disease, liberated from control, rapidly became epidemic; as long as every case was reported the epidemic was prevented, but no longer. The voluntary system answered for a time, but soon broke down, as it always will do, and as it always has done from time immemorial to the present. The experiment has been made so long that it is unnecessary to continue it; it has indeed lasted too long, and to continue it still is altogether unjustifiable. Of the nearly 300 practitioners in Birmingham only 113 have ever voluntarily notified. In saying this much, I don't mean that these 113 have all notified in each year, but only last year. Nor is it to be understood that they have notified all their cases, but only such as they pleased, and probably only a small proportion; or that they have notified them early, when alone notification is of much value.

In my Annual Report for 1877 I remark that, "out of upwards of 200 medical practitioners in the borough, only seventeen reported cases of disease during the whole of the year." The diseases notified have been, moreover, principally such as a fee is paid for, viz. scarlet fever and small-pox; the cases of diphtheria and typhoid reported are comparatively few, while of measles not one in a hundred has been notified.

Does any person believe that such a system of notification can achieve a real advantage in the way of protecting

public health, or lead to any result except the waste of public money?

The voluntary system answers very well in the case of cholera, because so great is the alarm and even horror excited by the disease, that it is practically compulsory, in other words, that result is effected by fear which is denied by reason. But in the case of a disease of which there is no fear, such as scarlet fever, although it is a thousand times more destructive to life, the voluntary system breaks down altogether. Instead of the medical man reporting every case of preventable disease, he reports only such as he chooses; he will report for instance the case of a domestic servant whose presence in a large and respectable family is considered objectionable, and whose removal is therefore desired, and she is removed to the hospital accordingly, but the next case he may for special but insufficient reasons decline to notify, although the danger to the public may be as great in the one case as in the other.

There is generally no reticence in publishing to the whole world the illnesses of royal or distinguished personages, and in much more detail than is required for the protection of the public health, while in notification of disease to the sanitary authority there is no publication at all; there is simply intimation accepted in confidence and acted upon with the sole view of benefiting the patient and the community. Notification to be of real value must not be optional but imperative; it must not be subordinated to individual interests or caprice, because it is then too uncertain, too partial, and frequently too late. As a fact I frequently receive from the medical man notification of cases of zymotic disease after being attended by him for several weeks, and sometimes after the death of the patient. This is under the voluntary system which obtains in Birmingham, although for such information a fee of five shillings is paid. To expect efficient, that is, complete notification by voluntary means, is to ignore all past experience, and to display a credulity which would discredit an intelligent child.

Another alleged objection to notification by the medical man is that it leads to the concealment of cases, and consequent spread of disease, but the proof of this has never been forthcoming, and the objection rests on mere assumption. Let us hear, on the contrary, what is said by some who have had experience of the actual working of the compulsory clauses, for a little practice is worth much hypothesis, however ingenious. Dr. Butterfield, when Medical Officer of Health of Bradford, wrote: "As to the allegation that people would conceal infectious disease, and not send for medical advice for fear of having the case reported, I can safely say that such has not been the case in this town." The Mayor of Macclesfield says: "Our experience is that compulsory notice does not tend to concealment, but rather the reverse." The Mayor of Oldham gives similar testimony, and the same with other towns; while in Dundee it was found that there was less concealment of disease after notification was made by the medical attendant than there had been previously when the duty rested with the householder. It thus appears that there is no ground for the assumption of notification leading to concealment, and if there were, it would constitute an argument against notification, whether by the householder or the medical man, and is therefore an argument against notification altogether.

It is further asserted that compulsory powers promote antagonism between the medical practitioners and the medical officer of health. If this be so, I am bound to say that I have failed to find evidence of it worthy of the name; it might be possible by diligent inquiry to discover a solitary case of the kind, but "one swallow does not make a summer," and it has happened more than once that conflict of opinion and antagonism have arisen between even practitioners themselves on other questions than that of notification. For many years in Birmingham there has been voluntary notification, but in no single instance has any antagonism, or even unpleasantness arisen between the medical men and myself. Abundant

testimony to the same effect is afforded in towns where the notification is compulsory; thus at Leicester, Alderman Windley stated that "all fear of collision between the medical officer of health and the profession had died out, and the certificates were sent in without difficulty"; at Bradford Dr. Butterfield reports: "I know of no medical man who is opposed to the working of the Act." The Mayor of Oldham states that "there has been no unpleasantness with the medical profession in putting the clauses into effect; they have as a body willingly co-operated with the medical officer of health"; and from Llandudno we hear that "to the credit of *all* our medical men, they work most harmoniously with the Board." After the unvarying testimony of such a cloud of witnesses there seems to be no ground for alleging antagonism, with which it would seem that opposition has possibly been confounded.

If such antagonism were found to exist between the medical profession and the medical officer of health, "'twere a grievous fault," and it would be necessary to discover the causes of it, and remove them, because no good is to be expected without the cordial co-operation of the medical profession with the sanitary authority.

It has been alleged that the conduct of the medical officer of health is likely to be inquisitorial, and that he may interfere with the patient, and otherwise take advantage of his opportunities to annoy and injure the practitioner. This contingency is so remote and improbable that it is scarcely worthy of serious discussion. No medical officer of health properly qualified for his duties could act in such a manner; to suppose otherwise would be to assume that, the moment a medical practitioner becomes a medical officer of health, he forgets professional obligations, and loses the instincts of a gentleman, which is not only absurd, but opposed to experience.

There have been doleful predictions that notification by medical men would be a betrayal and destruction of that

confidence which is necessary between doctor and patient; such would no doubt be the case in some instances if there were no compulsory law requiring it; if the secrets of the sick room were published, instead of the case being simply notified; if the object were to injure instead of benefit the patient and the community, and if all medical men were not placed under the same necessity to notify; when, further, it is the rule for the householder, as well as the doctor, to notify, the former can have no possible ground of complaint in this direction. Here is seen one of the advantages of the dual system. It was attempted by Mr. Hart in his "model clause" to meet this question of betrayal of confidence, and at the same time the objection of medical men to be put under a penalty, and in order to do this he proposed that compulsory notification should be put upon the householder, to whom the medical attendant must furnish a certificate, which the householder is bound by penalty to forward to the sanitary authority; while no penalty falls upon the medical attendant in the event of his refusal to certify. The weak point of this clause is that it is impossible to obtain the co-operation of all medical men without the imposition of a penalty, so that this objectionable regulation is really rendered necessary by the fault of the medical profession itself, which, therefore, cannot reasonably complain: "*salus populi suprema est lex.*"

It is a remarkable fact that out of thirty-eight towns in Great Britain which have availed themselves of compulsory notification, thirty-four have adopted the system of direct notification by the medical attendant, while thirty of these require notification also by the occupier; in three of them only does it rest with the medical man to notify indirectly or to the occupier, so that the dual system is found to be by far the most in favour; it is the one recommended by the Local Government Board in 1878, and by the Select Committee of the House of Commons in 1882; it is theoretically the only efficient one, and in practice it has been proved to work satisfactorily. It is the system embodied

by Mr. Hastings in his Bill of 1883, and it is, I believe, the one which commends itself to all impartial minds, and to all persons of experience.

The reasons why the medical man should notify appear to be so plain : he alone is qualified to diagnose the disease ; he alone, bearing in mind the ignorance, poverty, and other disqualifications of large numbers of persons, is qualified by his education, his appreciation of the necessities of the case, his freedom from interest, prejudice, alarm, or confusion, to notify it, and he would by his direct action save much unnecessary delay.

As a fact, where notification is carried out it is nearly always by the medical man, even under the dual system.

The householder, on the other hand, is disqualified to report with promptitude and certainty by a number of circumstances, partly for reasons already stated, and also for some others, as want of time and opportunity. One insuperable obstacle would be created by the impossibility of supplying every householder with notification forms, and if that difficulty could be surmounted the forms would soon be lost. It is desirable, nevertheless, to hold the householder responsible to meet cases where a medical man is not called in.

In one town only has notification by the householder been tried, viz., Greenock, and, as might be expected, the results are very unsatisfactory, as only something over 50 per cent. of the cases came to the knowledge of the sanitary authority ; but even under these circumstances the death-rate of the town diminished progressively and considerably ; it is therefore clear that with a more complete system a proportionately greater advantage would have been gained. Dr. Wallace, Medical Officer of Health of Greenock, concludes a very valuable and interesting report by expressing a fear "that no further material improvement will take place from notification by the householder." He is forced to the conclusion that the only satisfactory method of notifying infectious disease would be to throw the responsi-

bility on the medical practitioner, as well as on the householder; in other words, the dual method.

It has been urged as an objection against notification—and this objection holds good in the case of the householder—as well as of the medical attendant that it would be injurious to business. This is possible to a certain extent, but my experience shows that it is a great advantage, by removing real danger, and so permitting the business to be carried on with safety. In several instances I have had employés in large establishments removed to hospital, to the advantage of the patient and to the great relief and protection of the other inmates and the public; the proprietors have been shrewd enough to discover the advantage, and grateful for the assistance rendered. In such cases, of course, removal is carried out as quietly as possible, measures of disinfection and precaution are judiciously conducted, and no publicity results. But even should there be publicity, and the business suffer in consequence, either through customers avoiding the shop or the latter being temporarily closed, surely this is a smaller evil than the disease being allowed to remain unreported, and left to spread itself broadcast.

Circumstances have come to my personal knowledge which clearly prove the necessity of the sanitary conditions of lodging-houses being known. A short time ago two Birmingham artists who had been to Jersey for a few weeks returned home suffering from typhoid, and one of them died; the disease was traced to their lodgings. Such cases are quite common; people leave home to recuperate their exhausted energies at a maritime or other health resort, and in some lodging-house or hotel contract a dangerous, often fatal, illness. Notification would prevent such horrible catastrophes, and I am fully convinced that the hotels and lodging-house keepers would be benefited, instead of prejudiced, by the arrangement. If they were alive to their real interests, they would court examination and certification of the sanitary condition of their establishments rather than attempt concealment of

defects and dangers ; indeed, some hotel-keepers do actually have their hotels systematically examined and certified by a competent person, and such a course cannot fail to inspire confidence in their guests.

Milk-shops and schools are particularly liable to prove centres of preventable sickness and death, unless cases of illness in them are at once notified. It is wonderful to find any one prepared to contend that the proprietors of trade or other establishments should be protected at the expense of the whole community, and it implies a singular excess of innocent belief in the perfection of human nature to expect them in all cases to give notice of the danger in their midst, when at the same time they believe that their interests will be thereby prejudiced.

The absence of adequate and suitable hospital accommodation has been cited as an argument against notification. The objection has, however, much less force than at first sight it appears to have. Very much can be done without a hospital, though I am far from supposing that hospitals are not necessary and indispensable. There is, however, very generally a backwardness on the part of the sanitary authorities to provide them on account of the expense, and some powerful influence is required to put them in motion. It is a fact proved by experience that nothing conduces so much to this result as notification. The daily receipt from medical men of reports of zymotic cases that require isolation, which is not being obtained at home, inevitably leads to the provision of hospital accommodation, which otherwise would have been neglected, so that the absence of hospitals actually becomes an argument for, instead of against, notification.

On the other hand, the existence of hospitals, and of sanitary organisation, costly as they are, are comparatively useless without notification ; and, indeed, without it the provisions of the Public Health Act, particularly those included in sections 120–143, are a dead letter.

The absence of notification, full and complete, has a relation to the extent and cost of hospital accommodation,

which is worthy of notice. For instance, supposing every case of disease be reported as soon as made out, the first cases would receive proper attention and isolation, the disease would be nipped in the bud, and a very small hospital would suffice ; but if, on the other hand, first cases are not reported, the stamping out process fails, the disease rapidly extends and becomes epidemic, and then the most gigantic hospital fails to meet its demands. This relation between notification and cost of hospital accommodation, without regard to other considerations, seems to me a matter of the greatest importance ; and the fact should not be lost sight of that the main value of a hospital for infectious diseases is to treat first cases and prevent epidemics, and not to treat thousands of cases which might, with proper care, have been prevented.

In conclusion, I would point out how little can be said against notification, that what is urged against it is, for the most part, of a hypothetical and speculative character, and that its principal opponents are persons who have had no actual experience of its working. On the other hand, both the public and the medical profession, in those thirty-eight towns where it has already been submitted to a practical test, accept it with satisfaction. Would they do this if it proved on trial as objectionable as it was predicted ? Why, in these very towns medical practitioners who were at first bitterly opposed to the plan have, on seeing the results of its operation, ceased their opposition, and have become its most loyal and valuable supporters.

I trust the medical profession is being gradually educated up to a proper appreciation of its value, and to a becoming sense of their duties with regard to it. It would be a subject of the profoundest regret to find them in prolonged antagonism to a measure which is necessary to the public good, as has already been abundantly proved.

Such opposition can only be based on mistaken views with regard to the influence of notification on public health, on strictly professional interests, or on sentiment. It is clear that the first is benefited by it ; it would be difficult to

show that the second would be in any way prejudiced; and the third ground requires no serious consideration. The medical profession is, I am sure, too noble and too generous in its aims to let mere sentimental objections or considerations of self-interest, or a false professional *amour propre*, stand in the way of the public weal. We are the servants, and not the masters of the public, and it has been usual to regard our profession as the most philanthropic, benevolent, and self-sacrificing of all; but I fear that a continuance in opposition to a great sanitary step forward is calculated to jeopardise its reputation, and not the less so because, while a section of the profession is hanging back, the practical common-sense and prudence of the nation at large, as shown by the action of a considerable number of towns already, will step in and do the work without its assistance.

DISCUSSION.

Mr. WYNTER BLYTH said all present must have been impressed with the solemn words of warning which had been uttered by the noble President, when he stated that, as the result of forty-five years' experience of sanitary matters, we must be very careful in interfering with the liberty of the subject. Every one must agree with that observation, and those who wished for compulsory notification must make out a very good case indeed. He believed that a case had been made out for some alteration, though he would not go quite so far as the readers of the papers. Dr. Carpenter had made a slight error in stating that Manchester was the first to adopt the voluntary system, as that system was adopted by the parish of St. Marylebone some time previously. For a number of consecutive years they had had voluntary returns from the eight public institutions in that borough of all diseases, and the names and addresses of patients suffering from infectious diseases. These returns, which were in some cases weekly, and in others monthly, were printed and published every month. At the same time,

there was a great deal of voluntary action amongst the medical men in his district. It was difficult to give an exact calculation as to how many cases of infectious diseases were reported, but he heard directly or indirectly of about seventy per cent. Of course he heard of every death which occurred from an infectious disease, and of every case brought under the notice of the Poor Law Board, and in addition many medical men sent voluntary notices. There were a few medical men who for some reason or other never sent a notice, and evils had arisen from the wilful concealment of cases of small-pox. Very often a shopkeeper, on the ground that his business would be injured, begged the doctor not to allow the nature of the disease to be stated. But this, of course, was a very wrong thing to do. He thought, instead of its being a detriment to business, it would be really an assistance. All the great business firms in his parish sent early notice of any disease to the sanitary authorities, and he had never known disease to spread in any of these places. That was a just argument, that a certain amount of compulsory notification would do no harm to persons in business. He could not quite concur in the sanguine views of some of his medical brethren who imagined that notification would stamp out infectious diseases altogether. He was sure it would not; and for this reason, that there was an immense amount of infectious disease walking about the street every day, and the persons did not even know that they were suffering from disease. He might take the case of scarlet fever; and in country villages, during the prevalence of an epidemic, every third woman or man whom you met had a piece of flannel round his or her throat; and they would not believe it if you told them they had scarlet fever. They would say they had a cold, but this was not so. They more often had scarlet fever, and, going about as they did, the disease was widely spread. No amount of compulsion would make these people say they had scarlet fever. A case had lately come under his notice of a young gentleman who had a sore-throat, as he

thought, who went into a house where there was no scarlet fever, but a short time after he left scarlet fever broke out in the house. Of course that was not positive proof, but combined with other cases it had its value. If they had notification of infectious disease it would be extremely useful, and would diminish the death-rate considerably, but he did not think it would stamp out infectious diseases altogether. With regard to dual notification, he thought that duty ought to devolve upon medical men, as there were many persons in England who could not write.

Dr. CARTER said he would spend the ten minutes allowed to him in stating facts which showed, he thought, firstly, that these much lauded private Acts would not work without serious modification; and, secondly, that they did not control the spread of infectious disease more than it was controlled in other towns without such acts. On Feb. 15 of the present year, Dr. Ashby, of Manchester, published a paper to prove the advantages of the Manchester Act, obtained in 1881. The only fact of which he seemed cognisant was, that more infectious cases were sent into hospital than formerly, whence he inferred that there must have been more isolation, and therefore more good. He stated that "tradesmen may have the option of shutting up their shops, or of having a policeman stationed at their door, or of sending their children to hospital." Yet he saw no reason for thinking that these agreeable alternatives might lead to concealment of disease, or delay in summoning a doctor. He further expressed his belief that the inspectors were both civil and anxious to do their duty, and stated that there had been but little friction between them and medical men. Such were Dr. Ashby's opinions. The following were facts which might serve as a comment on them. Two months after the paper appeared, the *Lancet*, itself a great lover of compulsion, wrote: "In Manchester the death rate has steadily increased during the last three years, notwithstanding the general decline in English urban mortality." So much for the good effect on mortality. Now for the absence of friction. The very same number of the

Lancet reported that a deputation of influential Manchester medical men had just had an interview with the Health Committee, for the purpose of complaining of the way in which patients were removed to hospital by the sanitary inspectors without their sanction; and it was agreed "that in future no case of infectious disease should be removed to hospital, unless such removal be certified as advisable by the practitioner in attendance." Thus the great central principle of the Act was abandoned as practically unworkable two months after it had been proclaimed to the world as working well, and doing much good. Liverpool was Manchester's near neighbour. It had no compulsory notification law; yet, while Manchester's death rate had been steadily rising, its own had been steadily falling, till at length their relative positions on the mortality tables had become reversed. This was all the more striking from the fact that Liverpool was recently visited by what was termed an epidemic of typhus fever, an epidemic, however, so well controlled and so soon extinguished, that the mortality from the disease during the time of its prevalence was considerably less than the ordinary yearly mortality caused by it not very many years back, and the year's death rate was one of the lowest on record. That disease was steadily and surely declining, and would ere long be almost unknown in Liverpool. He would give a few more facts to show that the action of Manchester was not exceptional. Mr. Monks, a town councillor of Warrington, whose Act dated from 1879, publicly stated in evidence before the Liverpool Deputation that, if the "action"—i.e. the removal to hospital by the sanitary inspectors—had continued, it would "have utterly destroyed the operation of the Act," and a modification substantially like that of Manchester had to be framed. Mr. Monks was a supporter of the Act. Dr. Johnson, of Leicester, informed the same deputation that he should certainly wink at any non-compliance with the law as to notification on the part of a medical attendant on a rich man; while the Medical Officer of Health for Huddersfield practically admitted the tendency to con-

cealment by enlarging his schedule of diseases in consequence of there being "numerous cases where parents wriggle out of giving notice in mild cases of scarlet fever, declaring it measles, &c." But there was evidence of another kind to the same effect. The *Manchester Health Journal* recently sent a request to the 38 towns having compulsory notification Acts asking to be supplied with the number of notifications and the mortality for the first quarter of the present year. It was significant that only 21 towns replied. Their population was nearly 2¼ millions. The cases notified, excluding measles, were said to have been 2935, and the deaths 464. This gave a mortality of very nearly 16 per cent. (not 14, as the *Lancet* put it). The mortality from typhoid fever was 18, and in Edinburgh over 18 per cent. of the cases notified; but this was considerably higher than the highest average of the London Fever Hospital, where for many reasons the mortality was exceptionally high. For diphtheria, the rate was 35 per cent., or more than one in every three. Could any one believe that for those towns a complete notification existed other than in name? As to the control of infectious diseases. Edinburgh used occasionally to be visited by measles. With the view, therefore, of getting early control over this disease, it was to be notified, attacked at once, and extinguished before it could assume epidemic proportions. The result at first seemed disappointing, for in the ten months immediately after the Act was put into operation out of 4502 intimations 3210 were of measles. Then came a lull. In February 1882, however, the disease again made its appearance. Now was the opportunity for proving what the Act could do. And what did it do? The following figures would show. In February 440 cases were notified; but instead of that number falling to a half in March, as ought to have been expected, it increased to 1118, and in April to 1239—nearly 3000 cases in three months. Measles marched through the city quite regardless of the Act. This curious result being mentioned to Dr. Littlejohn by a member of the Liverpool deputation, he remarked: "This

epidemic induced me to approach the Corporation, and to say, We have no accommodation to isolate these cases; and what have they done? They have built a hospital at the cost of 30,000*l*., and the next epidemic of measles you will find very different." He was right. The next epidemic did not long delay. It came in 1883, and it was very different; for whereas the 1882 attack caused 71 deaths, the 1833 one caused 138. Three thousand cases were reported, of which 1005 occurred in the single month of December, and still the disease marched on, disregarding the Act with the hospital as it had formerly done without it, so that during the first quarter of the present year there had been reported 1709 more cases, with 53 more deaths. In other words, the mortality last year from measles in Edinburgh was far higher than it had been in the whole of England and Wales during its most fatal epidemics; while for the first quarter of the present year it had been nearly four times as great as in England for the same time. If Edinburgh's mortality had been proportionate to that for England and Wales it should have been 15 instead of 53. Yet the Medical Officer of Health believed that the proof of its beneficially affecting measles was so apparent that he desired whooping-cough to be added to the diseases to be notified. Accrington obtained her Act in 1882, and very quickly had an opportunity afforded her of testing its utility, for just at that time she was visited by scarlet fever. The following from the *British Medical Journal* for January 13th, 1883, would show how far it controlled the disease. "Accrington has just got rid of one of the most serious epidemics of scarlet fever that has occurred in England for some years . . . . . About 120 children have died. Yet at the very time when the powerlessness of the measure to control the epidemic was being most painfully demonstrated, the Chairman of the Health Committee, in reply to a letter of inquiry from Liverpool, expressed the opinion that it was "very beneficial in securing early information of infectious disease." In other words, the only apparent proof that the Act was very beneficial consisted in the fact that the mortality from scarlet fever was more than eight

times as great as it was in England and Wales generally during that year. Was such a proof satisfactory? Blackburn obtained her Act in 1879. In 1881 the mortality from typhoid fever was considerably more than twice as great; and that for scarlet fever nearly half as great again as in the county generally. Again, the following appeared in the *Lancet* for March 17 of last year: "During the seven weeks ending last Saturday, 42 deaths from fever were registered in Blackburn, representing a mortality nearly 8 times the average for the 28 large English towns. From the returns issued last year the death rate in Blackburn in 1882 was equal to 25·1 per 1000, which exceeded by 2·8 the mean rate in the 28 English towns. The excessive death rate might in great measure be attributed to two causes—zymotic fatality and infant mortality. The death rate from the principal zymotic diseases was equal to 4·47 per 1000 last year, against 3·59, the mean rate in the 28 towns." Yet towards the close of that very year Blackburn reported that the compulsory notification of infectious diseases was a success. He had given them the proof of the success—were they satisfied with it? Preston obtained her Act in 1880, and two years later the sanitary authority announced their satisfaction with its working. Most people would imagine from that that the death-rate was being reduced. Yet the fact was that the mortality had continued so persistently and so alarmingly high that, only a few weeks ago, a deputation from friendly societies and trades unions of the town, representing 50,000 people, went to the Town Council with an indignant remonstrance on the prevalent sanitary neglect. They pointed out that the true sources of disease were left untouched, that houses were allowed to be built over organic refuse, that middens were allowed to be emptied through living rooms, and that the town was under the control of inspectors unequal to their work; the moral of which, he supposed, was, that if sanitary authorities troubled themselves as much about removing the causes of disease as they did about removing the persons who, owing to their neglect,

had become attacked by it, there would be very much less occasion for compulsory notification or any similarly harassing legislation.

Mr. H. E. ARMSTRONG said it was evident from the manner in which some of the remarks of the preceding speakers had been received, that some gentlemen had come with their minds made up not to receive information and to be convinced, but rather determined not to listen to argument. They seem to have taken for their motto :—

> Notification is vexation,
> Inspection's twice as bad,
> For isolation there's no occasion,
> Disinfection drives me mad!

In the town which he represented they had for the last two years had in force the compulsory notification of infectious diseases, and during that time they had registered close upon 4000 cases. The system in force in Newcastle-upon-Tyne was what had been referred to by Dr. Hill and Dr. Carpenter as the dual system, and during the time it had been in force no hitch whatever had occurred in the working. Before the Act came into force, people were loud and extravagant in their demonstrations against it, but now the state of things was entirely altered. Not only had they compulsory registration, but compulsory disinfection, which required very careful management, but in no instance had they had to have recourse to law. Two years' experience of the working of this system ought to be of some value. The object of compulsory registration was, in the first place, to get particulars of disease. When a case of disease was notified to him, it was his duty to prevent its spread, and with this object a full and careful investigation was at once made into the circumstances. Particulars were filled in on a printed "Disease Inquiry Form" (copies of which he produced)—under about seventy different heads relating to possible source of infection or means by which it is likely to be spread, surroundings of the case, sanitary condition of premises, water and milk supply, &c. The forms were printed upon different coloured papers, each relating

to a different disease. Scarlet paper was for scarlet fever, green for enteric fever, grey for typhoid fever, mauve for typhus, and white for diphtheria, &c. Printed instructions were also left with the persons in charge as to how to deal with the sick room, &c., and, when the disease was over, the medical attendant signed a printed form of certificate that the place was ready for final disinfection, on receipt of which the Officers of the Corporation saw to the disinfection. It was not the business of the medical officer of health to interfere with the duties of the medical attendants of the sick. His business was the protection of the public, and had nothing to do with the patient. For isolating cases of infectious disease at Newcastle they had hospitals of different kinds, containing 96 beds, for small-pox and fever, and they were about to erect a new hospital of 96 beds, on the completion of which some of the beds in the old hospital would be discontinued. The staff of the Health Department last winter consisted of 24 persons; they had ample means for removing all infected cases if they could get them to consent to removal; they were well provided with ambulances, and had the most approved forms of gas and steam disinfecting apparatus. When the notification of infectious disease was first proposed the measure was received with great opposition, especially by doctors. Public meetings were called at which strong resolutions were passed in opposition to the movement; but directly it became law the public received the thing as inevitable, and gave it a fair trial. One of the greatest opponents at the outset was a certain doctor, who, he was happy to say, had since become a warm supporter of the movement. Now, what lessons had they gained from the Infectious Disease inquiry before described? This, that the public do not understand what isolation and disinfection really mean. They think that any kind of half closing-off of a place will do, but of course that is a great mistake. Proper isolation is very rarely practicable in private houses, and in tenement houses it is impossible. Disinfection also is not properly performed by private

persons. Now we know that this should done thoroughly, or there is little or no good in it. Many private doctors have yet to learn what isolation and disinfection really mean. The inquiry forms showed that infectious disease had occurred in connection with a great many business premises at Newcastle, by which the public were endangered. Thus, during the last eighteen months, the following cases among many others had been found :—

Twenty-two at shops (chiefly small, for the sale of provisions, greengroceries, fruit, &c.); three at hosiery shops; two at tailors' workshops ; three at public mangle-houses ; three at laundries; thirteen at inns or beer-houses ; three at dairies ; six in travelling drapers' families ; one a barber (who whilst suffering from small-pox shaved customers) ; one at a matchbox maker's ; three at an artificial-flower maker's ; one at the house of the charwoman to a large institution ; three in the family of the master of a large school ; one in a passenger by steamboat ; one in the household of a midwife.

In several of the foregoing instances the sick room opened directly into the shop, or the only approach to it was through the shop; in one case the sick room *was* the shop. In most of the cases of infectious disease notified from day to day there is not the possibility of isolation, or what is worthy of the name ; and in a large proportion we find no means whatever are being taken by the householder to prevent the spread of infection. The examples quoted show the necessity of such cases being brought to the knowledge of the authorities, for the purpose of being properly dealt with, so that the public may be protected.

As regards the death-rate of Newcastle, about which questions had been asked, the mortality last week was 14·4 per 1000 (the lowest on record), whilst the rate for the preceding year was about 25 per 1000. He did not say that this *post hoc* was necessarily a *propter hoc*. He believed that the notification of diseases in Newcastle had been beneficial, but too much must not be expected after so short a trial as they had had of it. Besides, with all these

various ways in which infected persons were ignorantly, negligently, or wilfully, spreading disease—the Corporation had no power to compel the removal of such persons to hospital. They sought it two years ago, but it was not granted. Without such power, three fourths of the good that might be effected by notification was left undone.

Isolation is the most powerful means for preventing the spread of infection. He had had peculiar experience of this in typhus, a disease very prevalent, and almost endemic until ten or twelve years ago in Newcastle. That disease had reappeared several times during the last decade, but had on each occasion been stamped out in a short time. This result was to the best of his belief entirely due to the fact that typhus, from its being almost confined to the poorest class of the people—over whom we have control as regards disease—is more effectually isolated in hospital than any other fever or than small-pox. If other diseases were equally well isolated they might be controlled in the same manner. In tenement property compulsory removal to hospital was in his opinion the only efficient means for preventing the spread of infectious disease.

The noble chairman in his opening address had alluded to the liberty of the subject in relation to notification of disease. He (the speaker) denied the right of any one to spread infectious disease.

Mr. WM. YOUNG said the previous speakers had looked at this question from a purely professional point of view. Now, he objected to the proposal for compulsory notification upon the ground that it was unnecessary, and would be utterly useless even if it became law. From a careful study of the Registrar-General's returns year after year, he found they were doing very well without legislation, for zymotic diseases were being reduced, and they would continue to decrease. This was owing, as he thought, to their now reaping the result of the latest sanitary arrangements. He suggested that they should let well alone, and should try another year or two without penal legislation. Upon the point that legislation would

be useless, he said that he had had a good deal of experience of zymotic diseases, although he was not a medical man, and had been in thousands of cases of measles and scarlet fever, and had never found amongst the poor that dread of infection which medical men would have them believe there was. Medical men were not sincere in their statements; they did not themselves believe in infection, and if they did they ought to be isolated, because they were the most dangerous persons in the carriage of disease. Dr. Littlejohn, to whom reference had already been made, stated that for 25 years he had been engaged in active sanitary work, and had a limited staff to cope with outbreaks of small-pox and fevers, and during this period he had brought up a large family, but had never communicated any of the diseases to his family or dependents, nor, so far as he was aware, had any of the authorities who had served under him contracted or communicated diseases to the public. He thought the bogey of infection was raised up to serve a purpose, and that it did not exist as medical men would lead them to believe. He did not wish to attack the medical profession in any way. Dr. Littlejohn said that to live in constant dread of infection was one of the surest modes of courting attack. If they were to attend to matters appertaining to health, to spend a little more money in sanitary measures, and to have fewer medical men about them, they would achieve happy results without their interference.

Dr. MAHOMED thought they were all fairly agreed upon the point of infection referred to by the last speaker, and consequently he would address himself to the subject of the notification of diseases. With regard to the remark of Mr. Young as to the split in the medical camp, no doubt that gentleman had the best possible evidence for saying that the medical profession never wished to force upon the public generally anything upon which they were not thoroughly agreed. Until they had agreed upon this subject no attempt would be made to enforce it by legislation upon the world at large. He

would first consider the objects which it was hoped to attain by enforcing the law of compulsory notification of infectious diseases. They had been inclined to look upon the subject in this light: that if they could only enforce such a law it would abolish all infectious diseases; but it was a most magnified view of the question. The question was a very simple one, and when he had finished his remarks the meeting would be surprised to see the small point upon which they were quarrelling. The objects to be attained by notification were three:—(1) Isolation or removal of sick persons; (2) In the case of certain diseases, viz., diphtheria and enteric fever, that the attention of the sanitary authorities might be called to the condition of the drainage in the house or houses in which the diseases had occurred; (3) That the sanitary authorities would obtain information concerning the existence and progress of an epidemic, and that being informed on these points they might take such measures as might be necessary to limit the spread of the disease. Now it was desirable that these objects should be attained; but let us consider whether compulsory notification was the best method that could be employed by which to obtain them. As to isolation and the removal of a sick person, what benefit would be derived in connection with such a disease? As regards measles, the most infectious period was during the first four days, and during that time no one could diagnose the disease. That, he thought, was one reason why notification could never check measles. The next disease was whooping-cough, and the same remark applied to that, with this addition, that whooping-cough was of such notoriously long duration that it was absolutely impossible to isolate any case or to put it into a hospital during the whole of its course. With regard to chicken-pox, that was a disease of small mortality, and it was impossible to do much good with that. This was proved by the fact that the metropolitan asylums had refused to admit cases of chicken-pox, whooping-cough, or measles into their hospitals; being a practical body, they said, with regard to these diseases, that they would have nothing to

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do with isolating them. Enteric fever was not an infectious disease in the ordinary sense of the term; it was an endemic fever, and was due to bad drainage. The same remark applied to diphtheria, the germ was in the place where diphtheria arose, and that was the poisonous place to be in; the danger arising from contact with the patient was not so great. Typhus was a disease which had been almost banished from London since the year 1871 or 1872, owing to improved sanitary arrangements. With regard to small-pox, it was absurd to talk about taking any steps, as that was an absolutely preventable disease; and if any one wished to prevent themselves from having small-pox, all they had to do was to be vaccinated. Some gentlemen might say "no, no;" but he was willing to put that to a practical test. He happened to be the father of five children, and was perfectly willing to have them re-vaccinated and put in the ward of any small-pox hospital, and he would guarantee that they would not take the disease. It had been proved over and over again that there was no risk in doing this. The first duty of the sanitary authorities should be not so much the notification of disease, as to impress upon every soul in London the importance of re-vaccination. With regard to scarlet fever, a certain amount of good might be done if every case could be isolated; but it was a disease which a great number of people had without knowing it, and consequently they could never sufficiently isolate cases of scarlet fever so as to effect any great improvement in the mortality. As to the advantage of good drainage, he thought the health officers had unfairly represented the question. His idea was, that it was the duty of every medical man in London to look after the house of his patients, and to prevent the patient from contracting disease. Medical officers of health might do good work in looking after the homes of the poor, and he thought doctors did not look upon medical officers of health as their masters, but really as their assistants. He approved of a voluntary notification of infectious diseases by the medical men, and he left the meeting to decide whether

compulsory notification by the householder was desirable or not.

Dr. DUDFIELD said he might inform Mr. Young that Dr. Littlejohn was one of the strongest advocates of the system of compulsory notification. Gentlemen who opposed the system did not know perhaps that it was the most democratic peoples in the world who were most decided in their views with regard to notification; they would not allow the exercise of individual liberty to become the means of inflicting injury on the community, preferring to protect the community at the cost of the individual. Dr. Carpenter said that he trusted to medical gentlemen giving information to their patients as a moral duty; the patient to have the responsibility of notifying to the medical officer of health; but this in his opinion was not a sufficient safeguard. It appeared to him that Dr. Carpenter's objections to the dual system were chimerical. He had drawn a terrible picture of the unpleasantnesses that were to arise between the private and the official doctor, but admitted that there was no evidence of any such unpleasantnesses in the past. He could not help feeling that this somewhat laboured, not to say fanciful, part of an interesting address was unjust to medical officers, and that it was a little hard to have put forward a theoretical objection when it was well known that everywhere where the plan had been tried it had worked admirably, smoothly, and pleasantly. Referring again to the cry of "liberty of the subject," he asked them to consider the case of a house containing many families. Was it right when infectious disease occurred in one family that the other families should be exposed to a terrible danger in order to conserve the liberty of an individual? The liberty of an individual to spread disease! He thought not. If any persons ought to thank medical officers of health for what they were striving to do in this matter, it was the poor themselves. Medical officers did not interfere much with the rich; they could not afford the time, and the rich did not need their help. The poorer classes would in time

come to regard the medical officers as their true friends. Many who had opposed most strongly the removal of their children to hospitals had been so well satisfied that, after compulsory removal even, they had voluntarily stated they would never raise a similar difficulty again. He had known scores of cases where people who had at first objected to the removal had afterwards come back to return thanks for what had been done. With regard to legislation, he might say that a Select Committee of the House of Commons considered this matter some three years ago, and reported unanimously in favour of the principle of notification; of dual notification, he believed. Sir Charles Dilke, who was a friend to the poor, told a deputation last year that they need not go at all into the question of the principle of notification because the Local Government Board was absolutely agreed upon it, having received information from all parts of the country where it had been tried, that it had been a success: what the Board was afraid of, was going too fast for public opinion. The vestry of the parish of Kensington had committed itself to the principle of notification many years ago upon his representation, and in 1881 they called a conference of the sanitary authorities to consider this question among others. At that conference thirty vestries and district boards out of a total of thirty-nine were represented, and without one dissentient voice the principle of notification was agreed to. Afterwards they went in deputation to the Local Government Board, when Mr. Dodson was in office, to present the resolutions; without, he regretted to say, any particular advantage. In Kensington they had a large amount of voluntary notification, for they obtained immediate notice of all deaths from infectious diseases from the sub-district registrars; all pauper cases were reported, the co-operation of the guardians being given to them to the fullest extent; they obtained information from the dispensaries, from some medical men, from the school board visitors and teachers, from the police, from the post office authorities, from resident medical officers of hospitals,

from clergymen, and others. Now what benefit had they derived even from this imperfect system of notification? Last year, wishing to see what was likely to happen from notification, if compulsorily carried out through the entire country, he made a careful study of the mortality from infectious diseases in Kensington for twenty-four years 1859–82. During the first twelve years, 1859–70, he was not in office, and his predecessor had neither notification nor hospitals to help him; but during the second twelve years, 1871-82, he was in office, and had both notification of diseases and hospitals for the sick, and the result was remarkable. After making correction for increase of population, there was an increase in the number of deaths, in the second period, in respect of two diseases only, small-pox and whooping-cough. Of whooping-cough, he would only say that it is one of the diseases of which they rarely heard until it had proved fatal, and its occurrence was never notified. Small-pox, on the other hand, was more frequently notified than any other disease, and yet the deaths showed a corrected increase of 134. This disease, however, was severely epidemic in four years out of the twelve, whereas in the first period of twelve years, only twice did the annual number of deaths exceed twenty. Measles exhibited a decrease, although, like whooping-cough, it was not notified; but he was not aware that they were entitled to claim any credit for the reduced mortality. A diminished diarrhœal mortality might be attributed in considerable measure to the coldness of recent summers, and be regarded, therefore, almost as accidental. It was when they came to scarlet fever and "fever," that the real grounds for satisfaction appeared, these being the diseases which admitted the latter of mitigation by improved sanitary arrangements, and the former of control by early isolation by removal to hospital. And what did they find? That the deaths from fever in the second period were 108 less than the number in the first period, without correction for increase of population, and no fewer than 448 less after such correction; and that the corrected reduction in respect

of scarlet fever was no less than 1053. In the first ten years of the first period no deaths from diphtheria were recorded. He was unable to account for the omission, except upon the assumption that no deaths from diphtheria were registered in Kensington—a somewhat improbable assumption—there being no records extant. He had thought it fair, therefore, to bracket scarlet fever and diphtheria in the two periods respectively, for comparison; and thus adding the deaths from diphtheria to the deaths from scarlet fever, only 23 in the first period, and as many as 213 in the second period, there was in the second period an absolute reduction in the number of deaths from the two diseases, amounting to 193, the reduction corrected for increase of population being 878. Taking the "seven" principal diseases of the zymotic class together, there appeared a corrected reduction in the number of deaths in the second period of no fewer than 1441. In other words, had the rate of mortality from these diseases been the same in the second period, 1871–82, as in the first period, 1859–70, there would have died 1441 persons in the twelve years more than did die; or 120 per annum—the difference between the actual annual average number (413), and the number corrected for increase of population (533). The zymotic death rate, he might add, which in 1859–70 was 3·6 per 1000 persons living, fell to 2·8 per 1000 in 1871–82; the deaths from these diseases, moreover, which in 1859–70 were 18 per cent. of total deaths, were only 15·4 per cent. in 1871–82. Other causes, doubtless, beside notification, contributed to bring about this satisfactory result; and they must not forget, as regards enteric fever, that this disease, under improved sanitary arrangements, has continuously and notably declined in England during recent years. Chief among these causes, and one, in his judgment, even superior in efficacy to notification, was the provision of hospital accommodation by the Asylums Board under the Metropolitan Poor Act, 1867. So highly, in fact, did he value this provision, that were he offered a choice between hospitals and notification, he should unhesitatingly choose

the hospitals, for this reason among others, that provision of hospital accommodation led, almost inevitably, to notification; whereas, judging from the experience of certain towns, where the system was in operation, compulsory notification had comparatively little value in reducing mortality from zymotic diseases if hospital accommodation were not provided.*

Mr. JAMES BAILY (Secretary of the "Vigilance Committee") said, with regard to the question of compulsory notification of infectious diseases, they were all equally anxious to stamp out disease. That was one of the greatest objects which human society could seek to carry out, but he took it they were all lovers of liberty, and the advocates of compulsory notification of infectious diseases must make it perfectly clear that such a law was absolutely necessary before they could call upon society to pass any such measure. There had been an opportunity under the system of private Acts in different places for testing this kind of legislation, and those who were opposed to the system had had an opportunity of examining the result of such a law in the 38 towns where it had been in force, but, as Dr. Carter of Liverpool

* The speaker referred to the subjoined table, which exhibits compendiously the facts stated by him in his address.

Diseases.	Deaths in 1st period, 1859–70.	Deaths in 2nd period, 1871–82.	Estimated No. of Deaths in 2nd period, 1871–82, corrected for increase in population.	Increase (corrected) in 2nd period, 1871–82.	Decrease (corrected) in 2nd period, 1871–82.	Nett decrease (corrected) representing estimated saving of lives in 2nd period, 1871–82.
Small Pox	160	395	261	134	..	..
Measles	629	803	1029	..	226	..
Scarlet Fever & Diphtheria	1076	883	1761	..	878	..
Whooping Cough	529	1080	865	215	..	..
"Fever"	535	427	875	..	448	..
Diarrhœa	983	1370	1608	..	238	..
	3912	4958	6399	349	1790	1441

The average population in the first period of twelve years (1859–70) was 90,000, and in the second period (1871–82) 147,300.

had shown, the compulsory notification of infectious diseases in these places had not resulted in a very marked diminution of disease. In fact the very place where the schemes of Dr. Littlejohn had been carried out in their entirety, namely, in Edinburgh, the rate of mortality was higher than in Glasgow, where the system of compulsory notification was not carried out. It could not be proved in a single case that the existence of the law had resulted in any marked diminution of infectious diseases. Now, those who advocated the compulsory notification distinctly stated that it was perfectly useless unless it could be followed up with compulsory isolation, and upon this point he thought the poorer and middle classes would never consent to such a law being enforced. Even those in favour of compulsory notification admitted that they did not intend to meddle with the rich, so that it amounted to this, that if compulsory notification and isolation were obtained it would apply solely to the poor, the rich being allowed to go scot-free. He thought those who were taken away in ambulances ran considerably less chance of recovery from the disease than they did in their own houses, and it appeared from statistics that the rate of mortality amongst the poorer classes where disease was not isolated was considerably less than in hospitals for infectious diseases. As Mr. Power showed in his evidence which he gave before the Royal Commission, the probabilities were that aggregation—(for it was not isolation, and it was an abuse of the English language to call it by such a name)—did more harm than good. He did not wish to insinuate that doctors desired to trade upon this matter, but he did think that there was a great amount of exaggeration. Instead of saying so he would quote the remarks of Dr. Hamilton, who said that the public mind must be brought back to a common-sense view of the matter; they must be reminded of the actual scenes of every-day life, of doctors going to the bedsides of patients, and that it was the exception for disease to spread amongst them. Even the mothers of children who were attacked with fever only in a very few cases contracted the disease. This was

very strong evidence in favour of what he had been saying. In Hastings a voluntary society had been established for carrying out this work without any law whatever; they employed a woman teacher to instruct the poor people as to what ought to be done in a case of fever; and zymotic diseases had been practically stamped out in that place; whilst in Edinburgh under the high priest of this compulsory law they had more disease than they had in Glasgow.

Mr. NELSON HARDY said it was quite evident that if some of the previous speakers had had their way, the public would be far removed from the adage that an Englishman's house was his castle. Such antiquated notions of liberty as had been referred to by the Chairman, and in times past by Macaulay and Milton, would not now be heard of. He was not ashamed to say that he belonged to the class which had been contemptuously spoken of as "the small section" of the medical profession who objected to the principle of compulsory notification altogether. Whether it was a small section or not he thought was immaterial, but it was a section of the profession, and they had at least the right to have their opinion, and to have what they said fairly regarded. When he heard it spoken of as a very small section of the profession, he was reminded of what Archbishop Whately used to say, that Government ought to be by minorities, for minorities were always in the right. Now if some of the medical officers of health could have their way, he thought they would shortly have arrived at the sort of paternal government which Macaulay ridiculed fifty years ago as tending to become a Paul Pry in every house, spying, eaves-dropping, admonishing, and choosing our opinions for us, but to such a form of paternal government he for one decidedly objected. He had not time now to go into half the speeches upon which he should have liked to have spoken, but there was one subject which had not been referred to, and he might be permitted to mention it. In the Exhibition there was a street of Old London, and upon one door might be

observed a large cross with the words, "Lord have mercy upon us." That was an example of the time when notification was in full force, but still the disease was not stopped, for, according to reports published by impartial witnesses, it was apparent that the plague increased, until at last they gave up all attempts at compulsory notification, and it had to be admitted that the whole thing was an entire failure. Notification could never be carried out now to the extent it was then.

Prof. CORFIELD said that some time ago, at the request of the Sanitary Institute of Great Britain, he undertook to make an investigation into the results of the carrying out of the Acts for compulsory notification of disease in towns where the Acts were in force. Having sent a circular containing 18 questions to a number of towns in the United Kingdom, he received replies from 18 towns. As facts were better than opinions in a matter like this, he would as briefly as possible mention the facts which he obtained. In the first place, the medical officers of health of these towns were unanimously of opinion that the Act was valuable, that earlier information was given of the existence of disease, that information as to cases which would not have been reported was given, and all but one were of opinion that the information so given had assisted in tracing the origin of the outbreaks of different infectious diseases. If a person came and said that the notification of disease would not help the medical officer in stopping its spread, he thought it was hardly necessary to waste time in answering such an observation. It had been said that notification of a case of measles would be of no assistance in preventing its spread, but that he denied altogether; for having lately received notice of the outbreak of measles in some schools in the parish of St. George's, Hanover Square, it had been effectually stamped out by the closing of the schools. In that case he was not aware of the epidemic until it had assumed such proportions that nearly half the children in one of the schools were affected, and had he known of it earlier it could have been stopped. As it was, directly

he took action the disease was very soon stamped out. An objection had been raised as to the interference with the liberty of the subject, but he objected to any person being at liberty to spread infectious diseases. In spite of the ridicule which was thrown upon the ancient practice of exhibiting flags and crosses on houses, he might state that in Boston (U.S.A.) at the present time this was done. He had with him a copy of the regulations upon the matter, which, shortly, was to the following effect: that the select men of Boards of Health should use all possible care to prevent the spread of infection, and to give public notice of infected places to travellers by displaying red flags. Any person removing these flags should forfeit not less than 10 or more than 100 dollars. The next regulation was, that in the event of infectious disease breaking out, the head of the family should immediately give notice to the select men of the Board of Health, and failing to do so he should forfeit a sum of 100 dollars. Another regulation was, that if a physician knew that any person whom he was called upon to visit was infected with such a disease, he should at once give notice, and in the event of not doing this he should forfeit for each offence a sum of not less than 50 or more than 100 dollars.

Dr. CHARLES WEST said that non-notification of contagious diseases meant concealment, and concealment meant the spread of such diseases. What first forced this matter upon his attention was that in a city in the south of France, to which he was compelled to go for the benefit of his health, he found in the hotel in which he was residing a contagious disease had broken out, and this disease spread very considerably. This led him to try and induce the hotel proprietors to take part in the establishment of a sanatorium for the reception of persons affected with contagious diseases, and he accordingly prepared plans which were put into proper shape by his friend Mr. Keith Young. This plan was at present in abeyance, but he had great hopes that he should still live to see the day when it would be carried out, and that all cases of contagious diseases

might be removed to a distance. As some doubts had been thrown upon the results of the notification of contagious diseases, he might perhaps be permitted to say that since the establishment six years ago of a Bureau d'Hygiène at Brussels, which provides for the notification of contagious diseases, and as far as possible for their isolation, typhoid fever had diminished nearly 50 per cent., and diphtheria and scarlatina in even a greater proportion. The results obtained at Havre had been almost equally striking, and had the Mayor of Havre been present, as he had hoped that day, that gentleman would have been able to tell them much better than he could do what the decrease in the rate of mortality from contagious diseases had been. Notification of disease was the diagnosis of disease, and the disease could not be treated or removed except where medical officers were made acquainted with its existence, and of the causes which tended to promote its prevalence.

Dr. TAAFFE said that sometime ago (1881) an epidemic of typhoid fever occurred in Brighton, and he had to make inquiries in order to arrive at its source, and after making over 800 inquiries at different houses, and inspecting the water of a well in the country, he found that the disease had its origin in a milk shop. The inquiry extending over a month. Now, if the law as to notification had been in force, he would have been able to at once trace the source of this disease, and so have prevented 28·6 per cent. of ninety poor families (supplied from the milk shop) from being attacked by typhoid fever. Such an instance was worth a thousand theories. With regard to the remarks of Dr. Mahomed about typhoid fever in Marylebone, he thought that if there had been a notification of the first cases the disease never would have spread. There was no doubt a great dislike to compulsion, but everyone came into the world by compulsion, and would have to go out of the world by compulsion, so that there need not be quite so much objection on that score during the comparatively short period of even the longest life.

The CHAIRMAN, in closing the discussion, said upon the whole it seemed that a case had been made out for the compulsory notification of diseases, though he did not think that with so much difference of opinion on the part of the medical profession that a case had been made out for compelling them to do more than warn householders of the true state of the case, and holding these responsible for communicating the necessary information to the medical officer of health. At the beginning of the meeting he stated that he thought the burden of proof should lie with those who proposed to interfere with the liberty of the subject and with the rights of property, but that both ought to be interfered with for the public good, and it seemed to him that the case had been made out to the extent he had mentioned. The importance of notification under new compulsory powers had, he thought, been rather exaggerated, for this reason, that all pauper patients were of course reported, school children were reported, and all those who were taken to hospitals; and the danger to those in a better station of life was much less, because being educated upon this question they were more alive to the importance of isolation. There was a tendency to over-estimate the probable amount of good to be derived from it, though he thought a sufficient balance of advantage had been made out to render such notification desirable. As an old sanitary reformer, he must confess that what had been most brought home to him was this, that there were times when, in spite of all precautions, some spread of zymotic disease could not be prevented; but on the other hand zymotic diseases did not practically spread to any extent where good conditions and cleanliness prevailed. In the case of model lodging-houses in London the poison of infection, to a considerable degree, was neutralized by the excellent sanitary conditions which prevailed.

Professor CORFIELD, in proposing a vote of thanks to the Chairman for presiding, said he was glad his Lordship had given the verdict in favour of those who were in

favour of compulsory notification, although he regretted that he had not seen fit to give it in favour of medical men being compelled to notify all cases of infectious diseases. He was afraid, however, that even if he had been allowed to speak for ten minutes instead of five, he would hardly have been able to alter his Lordship's opinion.

(The Conference then adjourned.)

APPENDIX.

Communication from Dr. Egeling, of the Hague, referred to in Dr. Carpenter's Paper.

The Hague,
May 31st, 1884.

My dear Sir,

I enclose a note on your questions about the working of our law against contagious diseases, and a table of cases of deaths from those diseases before and after the law. You will see by it the salutary effect of the law.

I must apologise for not having answered sooner. But I was too much occupied when I received your letter, and would answer it myself.

I hope my note and the statistics will be of some use to you.

Should the paper you have to read, or a report of the Conference in which it will be discussed, appear in printing, I should be very much obliged to you, if you would be so kind as to send me a copy.

Believe me,
Truly yours,
Dr. L. J. Egeling.

Dr. Alfred Carpenter.

ANSWERS TO SOME QUESTIONS UPON THE WORKING OF THE DUTCH ACT AGAINST THE SPREAD OF SOME CONTAGIOUS DISEASES, PUT TO DR. EGELING BY DR. ALFRED CARPENTER.

Ques. 1.—*Do the medical attendants always report to the Local Authority?*

The Act of 1865 regulating the practice of Medicine obliges the medical men (Art. 6) to give information within three days of a disease which endangers the public health, to the Medical Inspector of the province, and to the local authority.

The law against Contagious Diseases (1872) prescribes in Art. 16 that the obligation to report to the Medical Inspector mentioned in Art. 6 of the law of 1865 remaining intact, cases of Asiatic cholera or small-pox must be reported within twenty-four hours to the local authority (burgomaster).

Art. 19 of the same law obliges the head of a family to report a contagious disease within twenty-four hours to the local authority.

Now I am sure the great majority of cases are reported. In great towns some escape. But the rule is that the cases are all reported, with the exception of measles and typhus, I believe. The obligation of the head of the family was enforced, while without it, all cases in which no medical man was called in would escape. And this would lead to not calling medical aid in many cases, by shopkeepers especially, in order not to have the warning paper affixed to their house.

So in each case in which a medical man is called in, the case cannot escape without connivance between the doctor and the head of the family, as *both* must infringe the law.

But it cannot be denied that cases are concealed. When it is known, generally a prosecution is instituted, and in some cases a condemnation was obtained.

Ques. 2.—*Are the medical attendants paid for their report?*

No.

Ques. 3.—*What is the mortality from infectious diseases in Holland now, compared with its mortality in the country before the law was enforced?*

The Act of 1872 became law in May 1873, so the year 1873 was partly before the law, and partly under the law, and must remain out of consideration.

I enclose a table of the mortality from infectious diseases—typhus and typhoid fevers, small-pox, scarlet fever, measles, diphtheria, croup and whooping-cough during the years 1866–1882.

I omit Asiatic cholera because there was no cholera after the law was enforced.

Croup and whooping-cough are *not* under the law, the other diseases are.

A glance at this table is enough to see that the deaths from the contagious diseases on which the law bears, have considerably diminished after it was enforced. But the influence is very conspicuous when we compare the yearly average of the seven years *before* the law (1866–72) with the yearly average of the seven years *after* the law (1874-1880). I made the comparison at the foot of the table.

Now I must add, that I am convinced that after the law not *all* the cases of death from contagious diseases are registered as such. When a medical man has not reported the case while his patient was ill, it is clear that he will not fill up the schedule of the cause of death with the name of that disease when the patient dies. But *this* cannot account for so striking a diminution as the table shows. The salutary working of the Act is clear, and cannot be denied. That the diminution is a consequence of the law appears also from the fact, that after 1873 the deaths from croup and whooping-cough, diseases which are *not* under the Act, have *not* diminished. The yearly average of deaths from croup shows a little diminution, but that of whooping-cough augmented. I have also added in the table the number of vaccinations. It is clear their number considerably augmented after the law. The cause is, that though we have no compulsory vaccination, no child is allowed to go to a school (public or private school) without producing a testimony of *successful* vaccination.

Ques. 4.—*Have any prosecutions been instituted against medical men who do not report?*

Yes, and condemnations have been obtained. But it is clear that it must often be very difficult to obtain a condemnation. It must be proved not only that the patient had that disease, say typhus, but also that the doctor *knew* it was typhus. Now, when a medical man will conceal a case of typhus in connivance with the family, and call it continuous fever, or febris catarrhalis, or what you like, how can it be *proved* to the judges that he *knew* it was typhus? When he calls scarlet fever *rubeola*, how can the prosecution *prove* he knew it was scarlatina?

When cases of concealment of a disease come to the knowledge of the medical inspector, he will remember the doctor of his duty, and if this does not suffice, and the medical inspector becomes aware of another case of concealment by the same doctor, he will try to obtain a condemnation, when the peculiarities of the case are such that he has a good chance of success.

Ques. 5 *If— not, why not?*

See above.

Ques. 6.—*If notification is general, why have the diseases not been eradicated from the country?*

What steps are defective so that the diseases still linger in Holland?

Registration of the diseases is not enough. The law gives to the burgomaster the power of taking various measures, in various cases; for example, he can order disinfection, the objects that were in contact with the patient to be burned, &c. But the burgomaster is not *compelled* to do it! Now, in many cases, nothing is done. A paper with the name of the disease is placed on the door, or doors of the house, the children are not allowed to go to school, and that is all! The members of the family mix with other people, &c. Too much depends upon the burgomaster, but when proper use is made of the law its salutary effect is very conspicuous. It is a weak point of the law that the cost of *disinfection* must be paid by the local authority. To spare money no disinfection is ordered, and as the costs of expropriation and burning of infected objects are paid by the Government, the case occurs that where disinfection and burning is ordered, objects that could very well be *disinfected* (at the cost of the local authority) are *expropriated and burned* at great expense (at the cost of the State!)

Some amelioration of the law of 1872 would be very desirable, but it is much more difficult to have a law amended in Holland than in England! *

* The above appears conclusively to prove that until the State does its own duty, it is not in a position to enforce dual notification.—A.C.

In the Year.	Population.	Deaths from Diseases.*							Number of Vaccinations.	
		Under the Act.					Not under the Act.			
		Typhus and Typhoid.	Small-pox.	Scarlet Fever.	Measles.	Diphtheria.	Croup.	Whooping Cough.		
1866	3,530,047	3,786	1,413	393	854	503			46,385	
1867	3,552,597	3,246	542	505	750	537	990	1,284	51,801	
1868	3,592,416	3,745	143	325	1,680	526	1,044	1,141	48,527	Before the Law.
1869	3,628,468	3,424	50	283	1,095	649	1,220	1,084	63,426	
1870	3,652,071	3,438	706	266	1,955	699	1,336	1,144	64,501	
1871	3,632,237	3,084	15,787	662	1,236	548	1,133	1,045	452,469	Epidemic of Small-pox.
1872	3,637,285	2,892	3,731	922	2,227	492	754	2,292	59,234	
1873	3,674,402	1,966	351	819	751	422	870	1,120	133,931	
1874	3,715,737	1,240	130	566	550	332	931	866	88,207	
1875	3,767,263	1,306	195	244	1,196	402	1,190	1,404	91,737	
1876	3,809,527	1,303	113	103	870	304	941	997	100,836	
1877	3,865,456	1,055	26	136	578	327	741	1,827	100,525	After the Law.
1878	3,954,792	1,150	11	446	1,264	283	630	1,427	97,328	
1879	3,981,887	829	8	639	1,093	254	629	912	97,702	
1880	4,012,693	964	79	479	1,365	256	532	1,847	164,987	
1881	4,060,580	877	75	400	874	240	563	1,626	87,697	
1882	4,114,015	813	153	275	784	314	831	1,633	104,407	Epidemic of Small-pox.
7 years *before* the Law.							6 yrs.	6 yrs.		
1866—1872		23,615	22,372	3,416	10,797	3,954	6,477	7,990		
Yearly average		3373·5	3,196	488	1542·4	564·8	1079·5	1331·6		
7 years *after* the Law.										
1874—1880		7,847	562	2,613	6,916	2,158	5,594	9,280		
		1,120	80·2	373·2	988	308·2	932·3	1540·6		
SMALL-POX. Without the years of Epidemic, 1871–1872.										
5 years. 1866–1870			2,854							
Yearly average			570·8							
5 years. 1874–1878			475							
Yearly average			95							

* The above tables would show that croup and whooping-cough are not so amenable to those sanitary surroundings, which are under the control of the state, as are the other diseases. It is not shown that active measures were taken by the local authorities to diminish the causes which promote the spread of such diseases, but we may take it for granted that such endeavours were more general after the promulgation of the law of notification than was the case before the law was enacted.—A. C.

Conference on Saturday, June 14, 1884.

1. "*The Disposal of the Dead.*" By A. Wynter Blyth, F.C.S., M.R.C.S.
2. "*Cremation.*" By W. Eassie, C.E.

Chairman:

Sir J. M'Garel Hogg, Bart., K.C.B., M.P.

THE DISPOSAL OF THE DEAD.

By A. Wynter Blyth, F.C.S.

§ 1. The term "disposal of the dead," in its popular narrow limitation, means simply the disposal of human remains, but, taken in its widest significance, includes the disposal of everything which has had life, whether vegetable, animal, or human, for, as it has been finely sung,

> "O Death! thy mark is on the flower and on the tree,
> And on the beast, and on the bird,
> Thy shade is on the mountains, even the sea
> By thy sad foot is stirred.
>
> Slayer thou art of all my soul deems fair,
> Thou saddenest the sun;
> Of all things in the earth and sea,
> O Death, thou sparest none."

In this essay I must confine myself to the methods of dealing with human remains, those actually followed in civilised and uncivilised nations at the present time being pretty much as follows :—

§ 2.—1. Simple exposure, so that, according to the climate, the body is wasted by the slow influence of the elements, or is consumed by insects, birds, or carrion-feeding animals.

2. Burial in the ground in all its varieties.

3. Burial in the sea.

4. Burial in fire, *i.e.*, fire-burial or cremation.

5. Embalmment, under which head may be included all kinds and methods of preservation.

§ 3. All the varied methods of disposal of the dead adopted by man are carried out by Nature. Dead leaves, worms, insects, and animals, are covered up by dust, sand, and river drift—*Nature's burial.* In the Arctic regions, animal matters encased in ice are preserved indefinitely, and the fauna of prehistoric ages presented to our view unchanged—here see *Nature's embalmment.* Myriads of dead forms, both from the land and water, find their last resting-place in the ocean—*Nature's deep-sea burial.* It must, however, be confessed that the most favoured of all methods of disposal by Nature is that of the consumption of a dead being by one that is living—the burial of the dead in the quick.*

§ 4. Before entering into a methodical consideration of the disposal of the dead, it will be profitable to sketch

* Prince Siddârthra marked—

> " How lizard fed on ant, and snake on him,
> And kite on both, and how the fish-hawk robbed
> The fish-tiger of that which it had seized.
> The shrike chasing the bulbul, which did chase
> The jewelled butterflies, till everywhere
> Each slew a slayer, and in turn was slain.
> Life living upon death. So the fair show
> Veiled one vast, savage, grim conspiracy
> Of mutual murder, from the worm to the man,
> Who himself kills his fellow."

briefly the changes taking place during the decay of organic substances.

When such matters are neither desiccated nor frozen, nor eaten nor burnt, but exposed to air and moisture, they are rapidly attacked by living bodies of extreme minuteness called bacteria. The bacteria of putrefaction penetrate into the tissues, divide and multiply, and resolve their elements into simple chemical combinations; therefore, during the whole period of putrefaction, fœtid odours, foul liquids, and gases are produced. These phenomena are often compared to the phenomena accompanying slow combustion, but, as Liebig pointed out, if looked at simply from a chemical standpoint, the process is rather analogous to that of a slow distillation.

After series on series of chemical metempsychoses, all matters volatile and fixed are resolved by progressive degradation into carbonic acid gas, water, ammonia, and salts, but the process is so slow, so incomplete, that fossil human bones from the flint age still contain some unconsumed organic remnant of the ancient body.

§ 5. In certain spots devoid of putrefactive germs, in complete immersion in water, and in places where the air does not have free access, putrefactive decomposition does not take place, but is supplanted by other peculiar processes, such, for example, as those which have been named *mummification* and *saponification*. These changes and the conditions favouring them are but ill understood.

Exposure of the Dead.

§ 6. Simple exposure of the dead, either in special places like the Parsees' towers of silence, or desertion of the corpse, only exists among a few races and tribes. In the rainless regions of the earth, in which the hot sun and dry air prevent active decomposition, exposure is destitute of the loathsome character which it would possess in other climes. If traced back, the entire abandonment of the dead will, without doubt, be found to have a basis upon

fear, superstition, or a form of belief. An instance of the latter is afforded by the simple custom of the Chatham islanders; they place their kin in a canoe, and between the cold stiff fingers lay a baited hook and line. The boat with its silent burden is sent solemnly adrift on the great ocean, to float to some far-off isle of Avalon; there the fisherman will again rise and ply his craft.

These customs, however interesting, must not detain us; for they are for our present purpose more curious than useful.

We will, therefore, at once pass on to the various forms of earth burial.

Earth Burial.

§ 7. The origin of earth burial has been confidently ascribed to sanitary precaution; but, so far as I can see, the study of the habits and methods of thought of primitive man by no means countenances this view.

In the dawn of intellect, man is perpetually struggling with the forces of Nature—with heat, with cold, with winds, storms, and lightnings; these become in time to him incarnate, so that he moves among a multitude of mighty and powerful shades. Having once grasped the idea of invisible powers, ready to work weal or woe, the concept of ghost, spirit, or wraith is the natural sequence; he buries his kinsman, not because carrion taints the air, but because he fears the dead man's double. None have conceived these ideas with greater realisation than the Chinese; they use no cemeteries, but bury with great solicitude in any spot in which they think the deceased will rest in peace. Should they not succeed in giving this repose, the shade will make all their pursuits unfortunate and unlucky; hence they often exhume and re-inter if things are not prosperous.

§ 8. The custom of burial remains; the beliefs under which it was first practised are extinct. We may surround burial with whatever impressive religious ceremonies we like; but, considered in itself, burial in the earth is no religious rite, nor does its adoption imply any special belief or cult.

Within a time so recent as to be within the memory of men but little past their prime, Commissioners appointed to investigate intramural burial, revealed sickening and disgraceful abuses relative to the disposal of the dead, and led to enactments which have had a most beneficial effect in preventing interment in the crowded graveyards of large cities. Some of the graveyards were owned by obscure and solitary owners, whose direct interest lay in burying as many as possible. For example, the Spafields burial-ground, in extent just about one acre, was originally a tea-garden, but the speculation having failed, it was turned into an unconsecrated burial-ground, and in fifty years the proprietor had received fees for the burial of 80,000 bodies. The evidence in this and similar cases showed that directly the ground was full, room was made for other bodies by breaking up and burning the coffins, and often partially cremating the remains; I append in a foot-note * the evidence of a

* The evidence of Reuben Boom, a gravedigger at Spafields:—"I was in the employ of Mr. F. Green as gravedigger in 1837, and continued in his employ for about fourteen years. Our mode of working the ground was not commencing at one end and working to the other, but digging wherever it was ordered, totally regardless whether the ground was full or not; for instance, to dig a grave seven feet deep at a particular spot, I have often disturbed and mutilated seven or eight bodies; that is, I have severed heads, arms, legs, or whatever came in my way, with a crowbar, pickaxe, chopper, and saw. Of the bodies some were quite fresh, and some decomposed. I have had as much as 1½ cwt. of human flesh on what we term the 'beef board' at the foot of the grave at one time. I have often put a rope round the neck of the corpse to drag it out of the coffin, fastening one end of the rope to a tombstone so as to keep the corpse upright to get at the coffin from underneath, to make room for the flesh of other bodies. The coffins were taken away and burnt with pieces of decomposed flesh adhering thereto. I have taken up half a ton of wood out of one grave, because I had to take up two tiers of coffins, some of which were quite fresh, and we used to cut them up for struts, used for shoring up the graves. We had as many as fifty or sixty sides of coffins always in use to keep the ground from falling in when digging. We have buried as many as forty-five bodies in one day, besides stillborns. I and Tom Smith kept an account one year; we buried 2,017 bodies, besides stillborns, which are generally inclosed in deal coffins. We have taken them up when they have been in the ground only two days, and used

gravedigger, as reported in the *Times*, March 5, 1845. Fortunately these matters are historical, and not likely to be repeated.

§ 9. The ordinary method of inhumation in this country is to leave the body exposed more or less to the air for a few days in a room or mortuary, to enclose it in a wooden box—this, among the rich, in a leaden shell—and then to bury in the ground. If we trace now the changes that occur we find that during the period intervening between death and burial, the little invisible clouds of bacteria always floating about in the air, gain access to the tissues and organs, and according to temperature and other circumstances divide and multiply, and set up those changes which I have already detailed as belonging to the phenomena of putrefaction.

After death from infectious fevers, added to the ordinary emanations of putrefaction, there are those of an extremely dangerous character. The corpse after death from small-pox, typhus, and plague, has been known to be terribly infectious; and to a less extent after death from measles, scarlet fever, typhoid fever, and pneumonia. The infection may be conveyed by currents of air, or by actual contact with the body, or by the common household fly, or by domestic animals. Since it is improbable that the infectious material continues to be produced after life ceases, the infection in these cases must be that clinging to the corpse, which has been manufactured in the course of the malady.

§ 10. In the houses of those classes which can afford to occupy a whole house, the body can be placed in a room by itself, and during the short interval preceding burial any

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them to light fires with. I have been up to my knees in human flesh by jumping on the bodies, so as to cram them in the least possible space at the bottom of the graves, in which fresh bodies were afterwards placed. We covered over the flesh at the bottom by a small layer of mould. I have ruptured myself in dragging a heavy corpse out of a coffin. It was a very heavy one. It slipped from my hold lifting it by the shoulders. The corpse was quite fresh. These occurrences took place every day."

offence to the senses or injury to health may be but transitory and under control. But among the poorer classes of great towns, especially among those who have to eat, sleep, live, multiply, and die in single rooms, the disposal of the dead presents a problem of considerable moment to the public health. If the poor would immediately consent to the removal of the corpse to a mortuary, there would be little difficulty; but, naturally enough, the widow is loth to part with her dead husband, the mother with her child; and very unpleasant and distressing incidents result from this conserving of the body in living-rooms.

The usual course is to lay the body on the single bed, the family sleeping on the floor. I have seen myself the corpse of the mother of a family retained in a room for several days, the widower and five children eating their meals and sleeping in the same room. Not very long ago a person died of an infectious fever in the Middlesex Hospital, the relatives claimed the body, and actually conveyed it to a living-room situated in my district. There it lay for many days unknown to the sanitary authorities, with the result that three others were struck down with the same disease. There is no London district in which instances of a similar kind do not occur.

§ 11. The presence of various races in cities, whenever they form little groups or colonies, has more than a local influence on the public health. For example, the Italians, French, and Irish in London collect together and import any customs peculiar to their race or religion.

The last rites either of the Greek or the Roman Church, with its impressive ceremonial, the burning of tapers round the corpse, the drapery, the watching, and the praying, imported in even a modified form into the crowded houses of the poor, and considered solely from an hygienist's point of view, is more dangerous than the simpler rites of the Protestant, the Jew, or the Agnostic. We have most experience of the poorer Irish, in whom respect for their dead amounts to a passion. Whatever the deceased has died of, whether a virulent infectious fever or not, there is a gathering of

kinsmen and friends; the wake must be held. As for removal of the remains to a mortuary, such a step is in nearly every instance baffled as long as possible, sometimes even resisted by force. There is no medical man whose duty leads him into quarters tenanted by the Irish but who has occasionally found a room infected by fatal typhus, literally crammed with men and women, solemnising the occasion in their wild way; in all epidemics of typhus this custom has been one of the circumstances which has favoured its incidence and extension. The ravages of typhus among the Keltic races are not due to any individual susceptibility, but to the retention of old customs and to personal habits which specially facilitate the communication of infection.

§ 12. Another important practical aspect of the question is the ordinary inhumation of stillborn children. The bodies of these are often consigned to the undertaker, and naturally enough, without the form, publicity, and ceremony attending the removal of the remains of one who had existed a sufficient time to receive a name and to form household ties. The obscurity of these little nameless ones, and the indifference that is shown to their disposal, render possible the loathsome and secret practices which are from time to time disclosed; I of course mean the conversion of an undertaker's premises into a catacomb for the concealment of infants' bodies.

§ 13. The influence of graveyards or cemeteries on health naturally depends upon their proximity to dwellings, and above all upon their richness in remains actively decomposing. Around the old burial-grounds of London, when abuses were at their maximum, Mr. Ed. Chadwick's able and exhaustive reports* collected a number of facts, showing that the general rate of sickness was higher around the graveyards than elsewhere, and diseases, such as

* 'A Supplementary Report on the Results of a Special Inquiry into the Practice of Interment in Towns.' By Edwin Chadwick, London, 1843.

typhus, cholera, and erysipelas, if they broke out, were especially fatal in such spots.

Both modern and past research has shown that the earth of burial-grounds is permeated by the gases of decomposition to a far greater extent than ordinary earth; and what is called the "ground air" enters into houses in large quantities, being aspirated by the columns of heated lighter air raised by the warmth of our household hearths; hence an impure ground air almost necessarily produces an impure house air.

The chief gases are carbonic acid gas and marsh gas. One of the more exact recent researches on the amount of carbonic acid gas is that by Dr. Hesse.* In an elaborate research on various graveyards, his chief conclusions are—

That the ground air of churchyards is, almost without exception, richer in carbonic acid gas than the ground air of other places.

That the richness of the ground air depends upon the decomposition of the bodies, and is intimately connected with the penetrability of the coffin and the looseness of the graveyard soil.

That the content of carbonic acid gas commences to increase from the moment of burying; in from two weeks to three months it reaches its maximum; it then begins to decrease—the rate of diminution is slower than that of increase. The minimum amount of carbonic acid is reached, at the latest, in from ten to twenty years.

I know of no recent experiments as to the organic impurities of the ground air of graveyards, but we may from analogy conclude that it will be more germ-rich than ordinary air.

Springs in the neighbourhood of churchyards have been noticed to be unusually charged with carbonic acid gas, and occasionally to be contaminated without any

* 'Ueber den Kohlensäuregehalt der Gräberluft,' von Dr. W. Hesse. Archiv fur Hygiene. Erster Band, 4. Heft. Munchen und Leipzig

obvious cause, save from the proximity of human remains. For the most part, however, the evidence as to the pollution of water is of a conflicting character. Some years ago I examined a number of springs in the neighbourhood of churchyards in Devonshire, but they none of them showed any difference in composition from the other springs of the district. The power of the earth to assimilate and retain organic matters of the kind is so considerable, that contamination of water will only take place under exceptional circumstances.

A Rational Process of Burial.

§ 14. If we continue to bury our dead, the best process to my mind would be to begin on a new plan entirely; to bury only one body in a grave at a minimum depth of six feet; to abolish the use of vaults; to allow no irremovable headstones or monuments over graves; and to cause at the end of a certain number of years reversion to agricultural purposes.

The general details of this, what I venture to call the rational system, is as follows:—

First as to the space required.

In calculations as to the space required, we must allow for spaces between each grave, to avoid the uncovering of the coffin in one grave in opening another, and accident from collapse of the sides of the graves, and also must allow for paths or walks.

The average dimensions of an adult coffin are six feet three inches by one foot nine inches, so that 3887 coffins could be packed side by side in an acre of ground; but the proper space to give to each adult coffin, which will allow for walks, &c., may be put at forty-eight square feet, for children between five and fifteen, twenty-four square feet, and for children under five, twenty square feet.

In the year 1882, there died in London 82,913 people; of these 36,286 were infants under five, 4126 were under fifteen, and 42,501 were adults. The amount of burying space that they would require, supposing each body occupied one grave, and one only, would be as follows:—

	Square feet.
36,286 × 20 =	725,720
4,126 × 24 =	99,024
42,501 48 =	2,040,048
	2,864,792

Or very nearly sixty-six acres; allowing for increase of population, seventy acres of ground would receive decently all the London dead for 1884.

Taking London as an example, plots of a hundred or more acres would be selected north, south, east, and west of the Metropolis, drained and prepared. Great granite blocks as boundaries would be placed along the four sides of the area, and from these fixed points, lines would be drawn mapping out, and dividing the whole area into latitudes and longitudes, so to speak. By these simple means the position of a grave could be determined at any distance of time.

Temporary crosses might be permitted, but no headstones or monuments. The departed may be commemorated by cenotaph, by the adornment of public buildings, the erection of works of art. All of these modes of commemoration are more lasting than those usually adopted.

At the end of five years from the last burial, the ground in any plot would be cultivated but not built upon. Some might be turned into plantations, some into pasture or arable land. In either case, beneath the waving corn, or the stately pines, the remains would be free from desecration; their exact site could be determined, by the aid of the permanent boundaries, with mathematical certainty; the earth would not be robbed of fertilising material, and the acres and acres of cemetery ground which is now being

continually withdrawn from its office as a food producer would be utilised. The areas would remain for many years as open spaces; but should a quarter of a century elapse since the last burial, and some urgent public necessity arise for conversion of such an area to other than agricultural uses, then I see no objection to such conversion, provided due notice be given of the fact, and relatives be permitted to remove the remains of their ancestors should they choose to do so. Nor do I see any reason why, after a sufficiently long period, such an area could not be again, if necessary, converted into a burial-ground.

Few people, save those who have examined into the subject fully, realise the extent to which nearly every old burial-ground has been disturbed. I have seen gravestones built into the walls of dwellings, and cottage floors paved with them.* At Shebbear, in North Devon, in the repair of the church many years ago, a very large number of human remains were heaped up outside the door of the village inn. After a time some of the bones were carted away by a farmer, and he manured his fields with them; but most of the heap still remains, and when Medical Officer of Health in that part I carefully examined it, and ascertained the truth of the story.

The history of burying-places plainly shows that, what with the gravedigger and the alteration and enlargement of churches, no corpse is safely or permanently placed in the old yards; and if this is true of the old, it will also hold good with the new. There must come a time when the great cemeteries will be permanently closed, when the monuments and stones will be neglected and decay, and then the ground will revert to other uses. My proposal is an anticipation of this, the reversion being sooner, and the

* "Sepulchral stones of the seventeenth century are rare, for the utilitarian churchwardens of a former generation sent a large number to Newcastle to be turned into grindstones, and in 1796 they disposed of a further quantity for £38, and obtained 2*s.* 6*d.* for a stone figure." —("St. Nicholas' Church, Yarmouth"). 'Perlustration of Great Yarmouth.' By Charles John Palmer.

method of burial, I believe, more sanitary and rational. The proposal will, no doubt, to those to whom every reform relative to interment is looked upon with disfavour, be characterised as a scheme to raise cabbages and turnips from our defunct relatives. Some will oppose any suggestion favouring the use of what they would call unconsecrated ground; and, lastly, there is the objection to be met that, in course of time, there would be no rood of ground in the island which had not received a body.

§ 15. The transformation of the offensive products of decay into the vegetable world is the natural metamorphosis which is going on for ever and for ever, the building up of the fabric of life from the quarry of death. It is impossible to say whether the nitrogen, the carbon, the phosphates in the bread we eat, have ever formed an integral part of our ancestor or not. The grass, the flowers, and the corn, raise their slender stalks pure and unsullied from the soil, most of which has in some form or other itself lived. If, indeed, we are to be so sensitive in our food as to trace its origin to the corruption from whence it derives so many qualities, and to reject all foods which have been fertilised with what we might regard repulsive and offensive matters, there would be little left to eat. With regard to the objection to burial in unconsecrated ground, it surely is irreligious to regard any ground whatever as unconsecrated. To me it is all consecrated, and I refuse to believe any ceremonial sanctifies a piece of ground in a higher degree than the sanctification it receives when a good man's bones are there interred.

Lastly, with regard to the gradual conversion of the whole island into a burying-ground. There are about 18,500,000 acres in England which, mainly consisting of meadows and pasture land, may be considered more or less available for burial; taking as the basis the former calculations, viz., 66 acres for 83,000 interments, it follows that in round numbers 19,340 millions could on such an area be buried, each in separate graves, and that at the rate of 600,000 deaths annually it would take 30,000 years before

necessarily the old graves would be re-opened and again utilised.*

§ 16. Other minor reformed systems of burial have been suggested. Thus it has been proposed to bury in charcoal, that is, to encase the corpse in this material. Experiments have shown decomposition goes on in the presence of charcoal almost without odour, and the proposal is sensible and scientific. Persons dying of virulent fevers are sometimes buried in quicklime; such a method has the advantage of absorbing both the liquid and most of the gaseous products of decay; it is also popularly supposed to destroy the body, but if examined its action is only superficial, the continued evolution of carbonic acid gas soon turning the lime into the inert carbonate. Burial by encasing the coffined body in disinfectants, or the placing a deep layer of dry carbolic acid powder, or Sanitas powder over the coffin in the grave itself, are all attempts to make earth burial inoffensive to the living, and should be encouraged.

§ 17. Mr. Seymour Haden has advocated with great force inhumation without coffins; he would have the earth in direct contact with the corpse. There is no doubt whatever that if the burying-places possess a suitable soil, or if where the soil is unsuitable the ground be "made," such a method is generally far preferable to "coffined" interments. A fine granular mould rich in carbon has extraordinary antiseptic properties, and if the grave be dug sufficiently deep, the corpse will not be preyed upon by the grosser forms of life. On the other hand, after death from infectious diseases, a coffin gives an opportunity of encasing the body with disinfectants and facilitates its removal, and in such instances the disuse of a coffin might not be free from danger. Mr. Haden's plan might also be found inapplicable to certain clayey grounds at present used as burying-

* The total amount of land in England required to start the scheme would be a quantity sufficient for five years, viz., about 2400 acres (or say 2500 acres); after the five years a fifth of the original land taken would be yearly reverting to the agriculturist, and a fresh fifth, or a little more, according to increase of population, brought under burial.

places; such soils are apt to crack in dry weather, and are only in a small degree antiseptic

Deep-sea Burial.

§ 18. A great naval and maritime power, an insular position, the coast accessible from the most central parts of the country by rail, all afford considerable facilities for the disposal of the dead by sinking them to the depths of the ocean. As it is, a vast number of seamen and passengers each year receive, either as the result of fatal maladies at sea or of shipwreck, ocean burial, and it has been proposed to supplant inhumation by submersion. The advantages claimed are: that the dead would be removed completely from the living; that in the stillness of the great deep no desecration is possible; and that the departure of the ship with its melancholy freight, the consignment of its burden with fitting ceremony to the last resting-place, would be not destitute of solemnity, and such a method would be peculiarly suitable to a sea-loving nation.

On the other hand, there are fatal objections; imagine over 800,000 corpses carried out yearly from our ports, the transit by rail, the delays in the stormy periods of the year from stress of weather, the liability to shipwreck, and the absolute necessity for the vessels to go far out to sea, for public opinion would never tolerate the deposition of the bodies in the channel, or any comparatively shallow water near the shore, but they must be conveyed to parts of the ocean so deep as to preclude the possibility of the attacks of fish; and besides which the objection urged against cremation, viz., that it too effectually disposes of the body, rendering certain crimes difficult of detection, would also apply here, and with greater force.

Fire Burial.

§ 19. I pass now to two opposite methods of disposal, the one, fire burial, cremation, or destruction; the other,

embalmment, or the preservation of the dead. In perfect cremation "what the sun has compounded the fire analyseth, not transmuteth." The water of the body is driven off as steam, the nitrogen as nitrogen, the carbon as carbonic acid gas; the earthy matters alone remain as a white ash.

As in earth burial so in fire burial,* I see no grounds for believing that its origin was other than religious. Writers have ascribed to primitive races a sanitary forethought which they never possessed. The Northmen believed that the soul came down in the lightning to each babe that was born, and that which came down from Heaven in fire should so return. That the Greeks in times of plague, as well as the Hebrews on the field of battle, burnt their dead, was a proceeding more in the nature of a propitiatory sacrifice than founded upon ideas so far in advance of their time as those of preventive medicine. Early Christianity laid great stress upon the resurrection of the body. The Day of Judgment was considered imminent; the early Christians may be said for many generations to have lived in daily expectation of the final doom and destruction of all things; they therefore naturally looked with disfavour on any attempt to disfigure that earthly tabernacle which at the most in a few years was to be retenanted by the soul. But in this century, however strongly people may believe in the tenets of resurrection, to imagine that the unconsumed body is necessary for a participation in resurrection would be to deny the rising of the most eminent saints and martyrs who have been so freely burnt by rival sects. Hence we find members of the churches of England and Rome, and deeply religious men of all persuasions, ready to take a common-sense view of cremation, and whatever objections they may raise against its practice, hitherto

* "Others conceived it most natural to end in fire, as due unto the master principle in the composition, according to the doctrine of Heraclitus, and therefore heaped up large piles more actively to waft them toward that element, whereby they also declined a visible degeneration into worms, and left a lasting parcel of their composition: 'Hydriotaphia.'

there has been no very strong or united opposition on the score of impiety. This, I think, is a matter of congratulation, for such opposition is in its nature permanent, and not to be overcome by argument.

The practical aspects of cremation have recently received a fresh impetus in the form of a declaration by Chief Justice Stephen, to the effect that there was nothing in the English law forbidding cremation; and by a Bill which was introduced into Parliament, with the object of enacting regulations so as to ensure that the practice of cremation was not applied to the concealment of crime. The Bill was rejected, but the reception it met with in Parliament, the moderation of the discussion, and the general tone of the Press outside, plainly showed what a change had taken place in English opinion since the appearance of Sir Henry Thompson s elegant brochure, and of Mr. Eassie's numerous writings.

The only objection, of course, to cremation, is that the future identification of the dead, and above all the discovery of organic poison in cases where murder has been committed, would be rendered impossible.

The supporters of cremation desire to make it universal, and to encourage especially the poor to avail themselves of this method. If this principle is still to be adhered to, I cannot see any way of examining the corpse before cremation, for the simple reason that all scientific examination must necessarily be expensive. The suggestion of Dr. Cameron, that a medical officer of health's duty would be to properly inspect the body for a fee of five shillings, would not be received favourably by my profession; on the other hand, if cremation be considered the luxury of those who can afford an extra guinea or so, legislation of an effective character, affording every precaution against the burning of a poisoned body, would be easy. The simplest way would, I think, be to enact that any one desiring the cremation of his friend or relative should give notice to the coroner, who thereupon would direct a medical man to at once visit the case, make a post-mortem, and give the coroner a written

report; upon this report, if favourable, the coroner would give his certificate for the cremation. If there were suspicious circumstances, the coroner would act as in any other case.

The expense of the medical examination would, of course, fall upon the relatives of the deceased.

Embalmment.

§ 20. Embalmment, carried to such a perfection by the Egyptians, like all the rest, depended in its origin upon religious faith. If the Egyptians believed that after numerous metamorphoses, in some three thousand years, the soul would again retenant the body, it was only natural that they should take the most extraordinary pains to preserve that body.

The usual method in the present day is to inject a solution of chloride of zinc, dissolved in alcohol, into the vessels, so that the finest blood channels are filled with the preservative liquid. A corpse thus treated becomes wonderfully hard and resistant to ordinary processes of decay.

There are many cases in which embalmment may be necessary, such for example as for purposes of identification. I have a strong opinion that all persons found dead in the streets, and not identified, should be injected with a preservative and antiseptic liquid, and remain unburied in some special place for many months; and thus give opportunities of solving the problem of what are called "mysterious disappearances." The transportation of human remains, also, from one country to another necessitates some more scientific method than was adopted in the historical case of the great admiral whose body is said to have been brought home in a barrel of rum.

It is also a question, whether, if vault interments are to continue, some modified form of embalmment should

not be rendered compulsory, so as to lessen the risk of injurious emanations.

FUNERALS.

§ 21. I have left for final consideration the general subject of funerals. In Goethe's Autobiography, it is related how a man of fame, wealth, and influence, by the name of Ochsenstein, gave strict directions that after his death he should be carried to the grave in the stillness of early morning, without any pomp, ceremony, or procession. The injunctions strictly followed, in a city remarkable for the display and sumptuousness of its funeral processions, made a profound sensation. In a little while what were satirically called Ox-funerals became frequent, and display generally was diminished.

I would that an English Ochsenstein could be found, and that the same effect would follow.

The anti-Christian origin of the black plumes, the hideous hearse, the hatbands, the mutes, and the general ceremonial has so often been pointed out, that I will not dwell upon it. The efforts to show respect for the dead are, among the poorer and middle classes, made at the expense of the living; the portion of the widow and the orphan is cast into the grave, and there buried.

The crowd of gaping, idle people round the door of the darkened house; the passage of the cortège in the crowded streets, along which no person removes his hat, no carriage, cab, omnibus, or waggon slackens its pace; the drinking at public-houses of the drivers, mutes, and bearers; with many other objectionable accompaniments; show that, from beginning to end, the majority of funeral processions are in ceremonial without meaning, in costume an offence to the eye, and as a whole sadly destitute of impressiveness and respect.

A great deal of the display at funerals is for the public gaze, and supposing that funerals took place between 4 and 8 A.M., such a simple alteration would strike a blow at

much of the unnecessary expense, and be a first step to reform. There would be also other advantages, such as the non-interference with traffic, the stillness and solemnity of the early morn, the absence of crowds around the house; and in the case of the poor, the facility that it would give to the working classes to attend a funeral without necessarily losing a day's work.

§ 22. In conclusion, I may say that all who have given any attention to the subject are unanimous in one point only—the necessity of further reform in the present methods of registering the cause of death, and of conducting burial; but as to the direction reform should take, there is the greatest diversity of opinion. Whether ourselves or our descendants are to be resolved by fire, or buried in sea or earth—so long as the method finally adopted injures not the living; so long as it preserves decency, and in no way impairs reverence—the outcome of the controversy matters little.

CREMATION.

By W. Eassie, C.E.

The time has gone by when the advocacy of cremation of the dead necessitated an apology, and we have lived to see some of its bitterest opponents—men who had abstrusely searched for objections—positively commit themselves to the fact that the depurating power of the earth has been grossly overestimated, and that the universal destroyer fire is the only innocuous agent for complete dissolution. Nine years ago an untenable idea was promulgated to the effect that the process of cremation would rob nature of a most certain loss of ammonia, and the direst results were prophesied. This, the most discreetly-urged weapon against what we must now characterise as a great reform, fell abjectly to the ground, for it was an objection evidently manufactured to order.

It would appear to me, and I have been at considerable pains to adjust my ideas on the subject, that the declination of the human race in populous countries began with the time when dead humanities began to be huddled together in grounds apportioned for their reception. The mistake has been in believing that the near association of bodies of a kindred character in a churchyard is alone compatible with a veneration of the dead; and if, during the present century, this idea can be disabused, the remaining centuries will mark this one with a white stone. An almost countless number of men have testified to the shortcomings of burial in the earth, and as a mere satisfaction to myself, but thinking at the same time that it might be interesting, I took the trouble to count the number of recorded works upon the disposal of bodies, and I find that between 1539 and 1843, not less than 59 publications were issued in divers countries. From 1843 up to this month of 1884, 506 works or articles nave been published upon the same subject, and I will most willingly furnish a list of these works to any one desiring it. An idea of when the works upon cremation and kindred subjects will terminate could only be furnished by anyone possessing a knowledge of when earth-burial shall have become almost entirely abrogated.

Within the past few years the minds of Her Majesty's lieges have been very much exercised with respect to the disposal of their dead, and, to my knowledge, scores of more or less public societies have discussed Cremation *versus* Inhumation, and the secretaries—many of them eminent men—have been kind enough to forward me the results of the voting. I should say that only one adverse majority was reported in thirty divisions.

Being the Honorary Secretary of the Cremation Society of England—and I deem it an honour, in these days of vaunted reform, to hold such a post—I am in a position to guarantee these aforesaid facts; and having been the welcome recipient of thousands of letters upon the subject within the last few years, and having a lively knowledge of

the history of other sanitary reforms, as a member of council of sundry well-known societies, I am perforce simply discharging myself of my conscience to the public to say that, in my opinion, the question of the disposal of the dead transcends in importance almost every other question. The gong of Cremation was first struck in England by Sir Thomas Browne in 1858, the necessity for reform in burial drummed forth by Mr. E. Chadwick, C.B., in 1843, and the last and most effectual clangour upon the gong has just been rehearsed in the issue by Smith, Elder & Co., London, of those most masterly pamphlets of Sir Henry Thompson and Sir Spencer Wells; and rather than relegate it to a later period, I would call attention to the fact that the same firm publish other works on Cremation, notably the 'Transactions of the Cremation Society of England,' which has been made replete with information.

I think that the founders of the Cremation Society of England have chosen a very euphemistic term for the reduction of the body by fire, by calling it Cremation, for the same sound is shared in France, Italy, Spain and Portugal. In other than the Latin derived countries plain speaking is manifest. Hence the words LEICHENVERBRENNUNG, LIKFÖRBRÄNNING, TODTENVERBRENNUNG, FEUERBESTATTUNG, which simply mean corpse-burning and fire-burial.

It was under the head of fire-burial, or Feuerbestattung, that Dr. Kinkel pronounced at Dresden, in July, 1876, one of the most splendid orations extant in the German language, and its subject was Cremation, and a more enthusiastic reception could not possibly have been accorded to any proposed reform. I have listened subsequently to many speeches in Italy corroborating the necessity for cremation, and if the English-speaking people were only to exercise a tenth power of the energy shewn by Italy and Germany the rite would soon reign paramount amongst us.

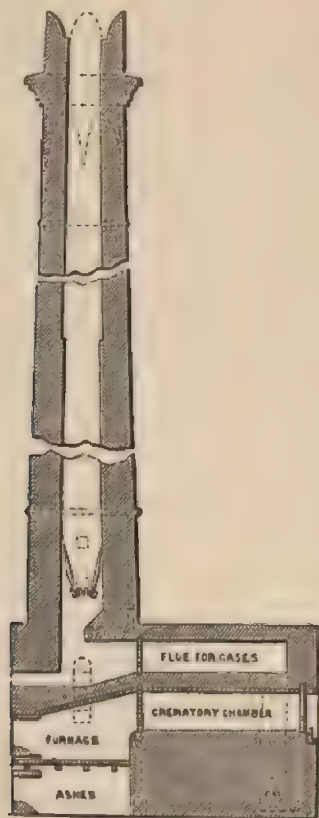
Thanks to the boldly-pronounced decision of Sir James Stephen during the late trial at Cardiff, Cremation has been lifted upon a pedestal, and Law has pronounced itself one of the supporters of its escutcheon. The Council of the

Cremation Society of England, however, knew from the foundation of the Society, that cremation was not illegal, and it was only in deference to the expressed wishes of the late Secretary of State for the Home Department that they surrendered their just right to make use of the crematorium which, at considerable expense, they had erected near Woking, Surrey.

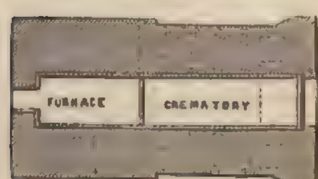
The crematory furnace consists of a receiver, a furnace, and a chimney. The receiver—which is above the crematory chamber—is a flat-bottomed chamber open at each end, one of which communicates with the upper part of the furnace, and the other with the lower part of the chimney. The furnace, which discharges its heat into the receiver, is somewhat spacious, sufficiently so to produce the necessary heat by means of wood fuel only if found requisite. The chimney is also of sufficient sectional area to remove the products of combustion from the receiver as well as the furnace, and high enough to permit the draught to keep above the gases pervading the receiver, and prevent any dispersion of heat or smoke through the apertures around the receiver or cremation chamber. In order to perfectly overcome the idea as to any organic molecules escaping from the shaft, a grating is placed near the base of the chimney, and upon this a portion of coke is kept burning. The products of animal combustion which issue still highly heated from the receiver or flue for gases, are subjected to a higher temperature in passing through the burning coke, and any organic matter which may have resisted or escaped the first combustion are destroyed by the second, and mix harmlessly with the atmosphere.

The idea of cremation being preferable to burial has been several times upheld by our Judges, and in March, 1882, in the Chancery Division, Mr. Justice Kay, in giving judgment in the case Williams *v.* Williams, remarked that he preferred cremation to burial as being the more sanitary practice. He would not, however, decide the question as to whether a man could, by any testament of his during his lifetime, bind his executors to accord his body the rite. It would

serve no useful purpose for me to recite to you the many observations and opinions of eminent legal men, sought for



LONGITUDINAL SECTION OF THE WOKING CREMATORY.



PLAN OF THE WOKING CREMATORY.

by the Council of the Cremation Society or otherwise made *public, and it* will be sufficient to say that there is no law

extant which could bar the practice of Cremation in any part of the British realms. The cremation of an English body, in Milan, whither it was forwarded by me, on the 15th of April, 1878, its reduction to ashes by myself and Italian colleagues, and the burning of the body of an infant by Dr. Price in Wales on January 13, 1884, proved plainly that no penalties could be associated with the practice of cremation in our country, and the recent three cremations in Dorsetshire proved the same thing, if further evidence was wanting as to the legality of the practice.

It is somewhat astonishing that it has taken so many years to prove to the public that this bestowal of the bodies was perfectly legal all along, and it does not redound to the credit of English jurisprudence that a short time ago a Rajah who consulted me as to burning the body of his Ranee had to be told that what he claimed as a right in India could not be accorded him in the capital of the Empire except at a risk of scandal. Fortunately, all this misconception has perished, and nowadays, provided the rite be decently performed in a suitable place, no objection can be maintained. It is here that the prescience of the Cremation Society of England, which was founded in 1874 by some of the most eminent men known to science, admirably manifests itself, inasmuch as it strove, and has already succeeded, in exhibiting to the English world a crematory building which is able to fulfil all that science and hygiene demands. Possibly, as time rolls on, some cheaper method of cremation may be devised, but I do not think that anything is likely to supersede, as far as facility of working is concerned, the crematory at Woking.

No temple or even waiting-room is as yet attached to this crematory, which is, as yet, only the necessary crematory furnace; but inasmuch as it stands upon freehold ground, considerately laid out with shrubs, it is to be hoped that the thinking public will willingly contribute towards the erection of the necessary adjuncts. One lives in hopes even that some giant mind will, out of some colossal purse, enable the Society to complete its self-imposed task of

shewing how cremation can be performed in a way to satisfy the most fastidious sense by endowing it with a sum sufficient to prove to the English public that we here, as well as abroad, are minded to beautify the useful.

It must be understood that the Cremation Society of England is a learned Society, and that it is not founded for trading purposes. It was established to prove the advantages of cremation over burial in the earth, and to shew how expeditiously, reasonably, and decorously it can be carried out. It is a sign of the times that the Commissioners of Sewers of the City of London appointed a sanitary committee to consider the advisability of building a crematorium at the Ilford Cemetery, in order that permissive cremation should be fairly established. A deputation of its notables visited the Woking Crematory on the 23rd of April, 1884, accompanied by Sir T. Spencer Wells, Mr. Ernest Hart, and other eminent members of the Society, and in their presence I reduced 124 lbs. of flesh and bone, forming the hinder part of a horse, to 4 lbs. of ashes in one hour, at a cost for fuel of five shillings and ninepence.

Previous to that, however, on the 1st of April, this year, I reduced 140 lbs. of a cow, containing the largest bones, to 4½ lbs. of ashes in an hour and a half, at about the same cost.

Some of the ashes of this last-mentioned cremation were exhibited by Dr. Farquharson, M.P., who himself witnessed a cremation, to the members of the House of Commons, present during the discussion of Dr. Cameron's Disposal of the Dead (Regulation) Bill, and they were justly apostrophised as appearing like frosted silver. I exhibit before you samples of a cremation carried out at Woking, and nothing more beautifully resultant could be desired. The second reading of Dr. Cameron's Bill did not meet the fate which it deserved, yet the division was in many senses a veritable triumph for cremation, and it will be very long indeed before the earnest speeches of Dr. Cameron, Sir Lyon Playfair, and Dr. Farquharson will be forgotten.

Upwards of fifty lectures have been publicly delivered

upon Cremation since the foundation of the Cremation Society of England, on the 13th of January, 1874, and the general consensus of opinion taken from the audiences, has been in favour of the introduction of the practice into England. Without attempting to account for it in any way, I will simply record that in point of numbers, as regards sequence, the supporters rank in majority thus:—(1) Medical men and surgeons; (2) Ladies; (3) Clergymen; and (4) Military men; the remainder belonging to the general public; and it is a matter of grief that well-known sanitary teachers are almost conspicuous by their absence from the roll-call of hygiene in this direction. We are happy, however, in numbering in the ranks such a prominent man as Prof. de Chaumont, F.R.S., who, at the conclusion of a lecture delivered by the Rev. Mr. Voysey, B.A., at Southampton, on the 10th of April, 1884, expressed his firm belief that if we could get cremation carried out, it would go an immense way towards preventing the terrible list of diseases which at present so afflicted humanity. This is exactly in harmony with words contained in a letter addressed to me in 1876 by that renowned sanitary pioneer, Dr. Parkes, and whose colleague I had the honour to be during the Crimean War in 1856. And it is a very curious circumstance, that on looking up my diary, kept at the time, I find records of visits paid to Dardanus, Troy, and elsewhere, in a certain June now twenty-eight years ago, and among the list of those who visited the Necropolitan diggings were honoured names, such as those of Dr. Parkes, Sir T. Spencer Wells, Sir John Kirk, Dr. Beddoe, F.R.S., and others.

Some of these explorers have departed for the silent land, as have also some of the members who, under Sir Henry Thompson's able presidency, founded the English Society. Men, I mean, such as the late Anthony Trollope, Shirley Brooks, and others.

The question of the disposal of the dead has exercised throughout all time the furthest ingenuity of men, and perhaps none but fellow members of the Anthropological

Institute are able to form any tolerable estimate of the apparent perversity with which they have acted. In some countries burial alone is performed, in others cremation, in some desiccation, in others ocean burial, and in my work upon Cremation I have instanced some very peculiar methods of disposal of the dead. It would project beyond the scope of this paper, however, to refer to the multifarious methods of dealing with the dead, and the jousts are open only for Cremation versus Inhumation, or Fire-burial versus Earth-burial, as the Germans very practically designate it.

I would not insult my hearers by attempting to relate the dangers due to burial in the earth, for to do so would be simply to repeat what I believe almost everyone has read himself or imagined for himself. I am myself tired with registering cases wherein disease has accompanied burial, and if I were to give to you even in the most condensed form possible the sense of the twelve hundred and forty pages of scraps relating to the disposal of the dead which I have collected for myself, and which remain in my possession, you would not, I am sure, be more convinced than you are now that wells can be poisoned, the air polluted, and disease result from the disturbance of ground where it was hoped that epidemical disease was finally laid to rest. Dr. J. Comyns Leach, in his paper read before the Popular Scientific Society at the Aquarium, on the 28th of March, 1884, described how it was possible, arguing upon the lines taken up by M. Pasteur, that even the very worms which work themselves through an infected spot of earth are capable of bringing to the surface those pores or germs which are capable of transmitting the specific disease. Medical works might really become interlined throughout if they were to do full justice to the reports of diseases engendered in this way; and it is something horrible to contemplate that not only a spadeful of earth, but that a piece of brick can contain lurking organisms of possible danger. This has been proved by M. Parize, and the propagation of a malarious fever in San Francisco has even been

traced to decaying woodwork. Given a body which has succumbed to confluent small-pox, and which has been interred in ground unsuitable for resolution, what fatal consequences might be predicted from the exposure of the organisms that must harbour in its rotting wooden enclosure.

It has been reported that the population of a small town in Gloucestershire was decimated in 1843 by the dispersal of the superfluous earth of the burial-ground for manure by well-meaning authorities. Surely all this points towards acclaiming a necessity for a purifying fire to intervene between the dead and living. The objections made to cremation are many, and appear formidable, but when confronted they fade into nothingness. Some hold that the body should not undergo cremation because the body of our Saviour did not. Others object to the rite because it does a certain moral cruelty to the body which did not deserve penal treatment. Some, again, clamour against cremation because it militates against a belief in the resurrection, and it is especially objectionable to those who believe in the resurrection of our present bodies. Well might the Earl of Shaftesbury remark to Sir Spencer Wells, that if utter obliteration followed cremation, what would become of the blessed martyrs? Others urge that the practice of cremation would bring about a disrespect to the dead, and would be a palpable return to paganism. Minor wailers describe it as a horrifying rite, and some scientists proclaim it because it would—especially if made compulsory—despoil our museums and medical schools of many interesting specimens for future study.

The only tangible objection made to cremation is that it might perchance serve as a screen to poisoners, and prevent the disclosure of their crimes. This is an objection which can be overcome in several ways. The objection does not apply everywhere, because persons die every day of easily-determined causes, such as small-pox, fever, consumption, drowning and other accidents, murder by weapons and suicide, and no cavil need obtrude in such

cases. With regard to more doubtful deaths, it would be necessary to make sure that the body exhibited no traces of poison, or that certain small portions of the body should be removed therefrom and kept for a few years. For instance, a small portion of the stomach and intestines and their contents, in case of vegetable poisoning, and a small portion of the liver should mineral poisoning be suspected. There is no difficulty in dealing with this matter in other countries, where cremation has become permissive; and it is upon record that the examination of the body of a child in Italy, which had been made in the ordinary way demanded by the authorities previous to the cremation, proved that the child had been poisoned, apparently by sweetmeats, and this would not have been revealed had an ordinary burial in the earth resulted. The Cremation Society of England, in their manifesto of March, 1884, which has been widely distributed, state that they are prepared to permit their crematory at Woking to be made use of for the reduction to ashes of human bodies, provided that those safeguards which they deem essential to associate with the rite, in order to prevent the destruction of a body which may have met death by unfair means, have been fairly satisfied; and they have published the conditions on which the employment of the crematorium will alone be permitted by the council, even then reserving the right of performing cremation.

The conditions are as follows: (1.) An application in writing must be made by the friends or executors of the deceased—unless it has been made by the deceased person himself during life—stating that it was the wish of the deceased to be cremated after death. (2.) A certificate must be sent in by one qualified medical man at least, who attended the deceased until the time of death, unhesitatingly stating that the cause of death was natural, and what that cause was. (3.) If no medical man attended during the illness, an autopsy must be made by a medical officer appointed by the Society, or no cremation can take place.

Surely these safeguards are wise and sufficient, and meet

all the objections which have been urged to nearly a humdrum extent by opponents to cremation. As regards the cost of burning a body, I do not think it likely that for some time to come it could be performed for less than, say, four or five pounds, so as to pay for the use of attendance, for the fuel, and a respectable fee towards the wear and tear of the crematory. I have not the slightest doubt, however, that when crematories abound, and abound they must, that the cost of a cremation in a public building might be reduced to a sovereign, or even less in the interests of the poor. What shall be done with the resulting ashes will probably be left for the decision of relatives, after they have been reverently removed from the tray of the crematory. It is possible that columbaria, such as I have seen at ancient Rome and modern Milan, may be requisite, and the plot of ground at the Woking Crematory could itself accommodate millions of urns. Society will, doubtless, require burial of the ashes; at all events the stowing away of them in the household would be deprecated, unless in cases of mansions where, with due decency, specific repositaries became possible. In ancient times the Thebans promulgated a law to the effect that no one should build a house without setting apart a place for the reception of cinerary urns. The common practice, however, in ancient times was to inter the urns in grounds allotted for the purpose, and the custom will doubtless commend itself to the community of the future in most countries.

Crematories are now in full use in Gotha, Milan, Rome and other places, and during the last few years some five hundred bodies have thus been withheld from lingering corruption. Cremation societies, scores in number, with thousands of adherents, exist in France, Holland, Sweden, Spain, Portugal; and the utmost endeavours are now being made to legalise the practice in countries where nothing but burial in the earth is now recognised as legal. In America societies are born yearly, and the adoption of cremation there will be merely a matter of time in each State of the Union. In far-off Japan, and even further,

ancient systems of burning the body are being exchanged for modern ones, and soon there will not be possibly in the whole world, China and Turkey excepted, a country which does not adopt or permit of fire-burial.

I have explained the construction of the crematory near Woking, but previous to the invention of this peculiar crematory by Prof. Gorini, common methods of cremation upon funeral pyres were resorted to, notably in the case of the poet Shelley in July, 1822, and of the Rajah of Kolapore in 1870, both in Italy. The first attempt at scientific cremation in modern times was made by Prof. Brunnetti, at Padua, and three bodies were destroyed by what he called his "Adamitic" process, a full description of which I gave to the public at a meeting of the Society of Arts on the 13th of February, 1878, illustrated by a model kindly lent to me for the purpose by the Cremation Society of Milan. On the same occasion I exhibited expensive models—which were brought over at great cost to me—of succeeding and more improved media for cremation, including the Polli-Clericetti used for the cremation of Signor Kellar, at Milan, on January 22nd, 1876, which was greatly admired, owing to the very ingenious use made of illuminating gas. After the invention of the foregoing followed several other species of crematories, among which might be noticed the Teruzzi-Betti apparatus, which widely departed from precedents. Next came the experiments made with the Siemens regenerative furnace in 1874, by Sir Henry Thompson in England, and by Prof. Réclam in Dresden. The success which attended these experiments demonstrated to the whole world that cremation could be performed within two hours at the expense of a few shillings, and an ordinary body reduced to some three pounds weight of pure white ashes.

The late great-hearted Sir William Siemens presented the Cremation Society of England with elaborately-drawn designs for a crematory, but they were not able to adopt them. A most beautiful model of a Siemens furnace, exactly adapted for cremation, was most kindly lent to me

for exhibition at a lecture I delivered at Leamington, in October, 1877, by Mr. Frederick Siemens of Dresden, and this pattern of crematory I had already seen in use in that city. A more efficient system for town uses could not be devised, and it was adopted by the authorities at Gotha. The crematory chosen by the English Society is built upon the Gorini pattern, a plan of which I exhibit, and it possesses several special advantages, the chief being that the commonest fuel can be made use of. Indeed, on a late occasion I destroyed 120 lbs. weight of a carcase at Woking, chiefly with a few faggots of wood which cost only threepence-halfpenny each, and I think it is very likely that crematoria of this pattern will be chiefly resorted to for district uses. A cheap temporary crematory, devised by Mr. Richards, of Wincanton, was made use of in Dorsetshire at the cremation of some of the Hanham family in October, 1882, and it performed its work reasonably well. Within the last few days the remains of a so-called ancient Roman crematory have been discovered during some excavations at Lincoln, and it will be very interesting to know the exact arrangements which prevailed in those days, although they would, of course, be of a most temporary character.

The public mind is now exercising itself almost to the utmost degree in all subjects relating to the disposal of the dead, and whereas some few years ago only one paragraph might have been seen in a newspaper throughout an entire month, it is rare that nowadays a newspaper can be conned without referring to the subject in some prominent manner. Especially is this true of the medical press, and numberless items of information, gleaned from foreign sources, are copied into our current literature. The truth is this, and no one can hope to disguise it, that we are up in arms against the dangers accruing to modern burial, and the scenes which attend every examination into the condition of a graveyard which has aroused suspicion will prove this statement.

The last-published report of an examination into the condition of a churchyard was held last month, at Northaw,

near Barnet, and I do not envy the feelings of anyone who could read it without feeling an utter repugnance to a state of things which rendered the disclosures possible; and yet this was but a mild case, compared with scores of others. It is computed that not less than five millions of bodies have been interred within the Metropolitan district within the last seventy years; and as London extends in area yearly, even the most suburban cemetery will soon have become surrounded by inhabitants, and the evils due to crowded-up, putrefying matter will some day form the subject of a national outcry. Invention has almost run riot in its endeavour to palliate the horrors of the tomb, and the records of the Patent Offices in all countries betoken this, and coffins of glass and iron, and other metals, are mentioned therein with nauseous frequency.

Within the last few days the public have been informed concerning the present state of the graveyards in the Crimea, where lie interred our valiant dead who fell there during the war; and it has doubtless been shocked to hear how they lie so scattered about, how badly they have been tended, and how costly it is to keep them in anything like repair. The treatment of the dead who have perished in the battle-field has frequently formed a topic of discussion at health conferences abroad; and many devices have been mooted of bringing cremation to bear here where it is most wanted, and thus save the unutterable amount of ghastliness attendant upon disinterring the bodies in order to burn them, and so avert danger to the living. This shocking spectacle of exhumation, followed by the rudest cremation, happened at Sedan, when a great number of exhumed bodies had to be consumed with pitch and straw. Very much wiser than we were the combatants of ancient Grecian times, who consumed their dead upon the field of battle, thus enabling them to bring the ashes home to the Fatherland.

During the conference of the Royal Italian Society of Hygiene, which is to be held in September next, in Turin, the cremation of the bodies of those who have perished in

warfare is especially to be considered, and I am of opinion that when next a great continental war occurs—and may such a thing be averted!—perambulatory cremation will be a common sight in the camps. Not less repugnant to Mother Earth is a glut of bestial carcases, and it was wisdom on the part of the French to give to the fire some four thousand dead horses in the battle of Paris in 1814; and if during the very virulent cattle plague which raged in Great Britain in 1865, the first moiety of the ninety-eight thousand of cattle which died, or had to be sacrificed, had been committed to the flames, the disease might have been quickly stamped out.

I could go on for hours enumerating the dangers attendant upon burial, and the advantages of cremation, especially in cases of persons who have perished from disease, but I think that I have said sufficient to inoculate my hearers with a sense of the necessity of at least permissive cremation, and that by their joining Cremation Societies they will be conferring a boon upon generations yet unborn.

The thanks of all sanitary people are due to the joint Committees of the Society of Medical Officers of Health, to the Sanitary Institute of Great Britain, and the Parkes Museum, for the introduction of the subject of Cremation of the dead into this Conference, and their example might be wisely followed by kindred societies. It is time, too, that some State regulations should be formulated, such as were contained in Dr. Cameron's Bill, and such as have been published by the Cremation Society of England. Unless something of this kind be done, and all objectionable and indecent methods of cremation be forbidden or the practice of them be made penal, we shall have frequent trials at the assizes, owing to the burning of bodies without even communicating the cause of death to the proper authorities. The last scandal in this direction was where two women were indicted for burning an illegitimate son of the younger in a fireplace belonging to the house, and the subsequent holding of an inquest by the coroner upon certain ashes

and charred bones. This occurred near Scarborough on the 14th of January last. It was not suggested that the prisoners had killed the child, and Mr. Justice Hawkins, in respiting judgment till the next assizes in order that the point raised might be discussed before the Court of Criminal Appeal, stated that he agreed with the decision in the Welsh Cremation case, but thought it was well that the law should be finally settled; by which, I take it, he means forbidding cremation otherwise than in proper crematories.

DISCUSSION.

Dr. CAMERON, M.P., said the subject of the disposal of the dead was one of the most important that could well be discussed in connection with a Health Exhibition, as must be apparent to anyone who has studied the subject. If anyone wished to study this subject in a nutshell he would advise them to read a report to the Board of Health upon inter-mural and extra-mural interments, published in the years 1850 and 1851. According to the last reports of the Registrar-General, it appeared that in England and Wales there died and were buried without the slightest investigation into the cause of death, or without a certificate as to the cause of death, as many persons as died in the entire Metropolitan District in the course of three months; and in England, Scotland, and Ireland, the number of persons who died without any investigation or certificate as to the cause of death and were buried, amounted to as many persons as died in the entire Metropolis in five months of the year. From the reports of the Board of Health, to which he had referred, it appeared that in the case of the poor, where there was no choice of chambers, it was no uncommon thing to have the body of a person who had died from some infectious disease, lying unburied for a week or more poisoning the inmates of the same house. When these bodies were consigned to the grave they were still a source

of poisoning to the living. So great was this evil considered to be by the Board of Health and by Commissioners who had investigated the subject, that it was proposed by the latter that the nation should buy up all the cemeteries in England, and that they should erect public mortuaries in every large town for the reception of dead bodies, and that the Government should take over the whole system of burial at fixed tariffs. That seemed a very far-fetched idea, but so far as Government regulating the tariff of funerals was concerned, that was a system which prevailed in France and in other continental countries. Mr. Blyth had suggested a much more moderate reform, and it was an excellent one so far as it went, but it ran altogether counter to popular sentiment. The mere fact of utilising the dead for agricultural purposes, although not repugnant to the scientific mind, was not calculated to gain much support from the public. The remedies suggested by Mr. Blyth as necessary to bring about rational burial, were that only one body should be buried in a grave and at a minimum depth of six feet, and that the use of vaults should be abolished; and there could not be any difference of opinion upon the first point; but as to the sufficiency of six feet of earth he thought it would not hold water, for if a body was buried in thirty feet the gases, and from a much greater depth than six feet, germs would escape to the surface and reproduce disease in man. The vault was a most objectionable system of burying, as it involved the use of lead coffins which prevented the decomposition of bodies in some cases for more than sixty years, though in one sense it was a safe system as the germs were safely sealed down. With regard to cremation, he thought it was very hard that if a person wished to be cremated that it should not be allowed. He did not believe that during the life of any of those present cremation would supplant burial; but that morning he had received a cutting from an American paper, announcing that the trustees of Messrs. Le Mon, in consequence of the number of bodies sent for cremation, intended to give

up the business altogether as Mr. Le Mon had built the crematory for his own use. That seemed to show that the system was looked upon with favour in America. He could not see why the same feeling should not actuate English people; and if a more rational and what he and many others considered a much less repulsive form of disposing of the dead than burial could be introduced, he did not see on what ground the Government had a right to interfere in the matter. As to the objection raised that cremation would enable crimes to go undetected, he thought that was all nonsense, especially after what he had stated about the numbers who went to their graves without any investigation or certificate of death. The Cremation Society had already provided for this difficulty, because they insisted that every precaution should be taken before a body was cremated. Now, with regard to the sentimental view. It was only a short time back that he received a letter from a lady, saying that if she could be sure that her body would be cremated half the terrors of death to her would be removed. Having mentioned this in Parliament when the subject was being discussed, one member, who he was sorry to say laboured under a malady which this gentleman believed might any day prove fatal, said to him that he could re-echo the sentiment. Although every one did not regard the matter in the same light as he did, he was sure that a large number of persons held the same view; and, therefore, he claimed on their behalf a right under proper precautions to ensure public safety and health to be allowed to exercise their own judgment in the matter.

Sir SPENCER WELLS, Bart., thought that the question of danger to the living from earth burials was one that should receive careful attention. Mr. Blyth had described the dreadful things which occurred in old town graveyards, and what Dr. Cameron had stated as to the Cemetery at Bethnal Green was only one proof among many which might be given to show that suburban cemeteries were approaching the condition in which town burial places were a few years ago, and that they were becoming so crowded

as to be dangerous to the people round about. The great danger under the present system of burying the dead was that it was the means of propagating infectious or contagious disease by preserving the germs or seeds of the disease. He knew an instance of a clergyman who had taken into his garden a piece of an old disused burial-ground, and upon this ground being dug up scarlet fever of a malignant type broke out in the clergyman's family and spread all over the parish. It was afterwards ascertained that in this portion of the old disused burial-ground, patients who had died of scarlet fever had been buried thirty years before. This was one instance of how disease might be perpetuated. As to the expense of cremation, he thought it would be very easy to prove, putting aside the preliminary expense of purchasing the land and erecting a crematorium, that the expense was very small. Mr. Eassie calculated it at £4 or £5, including a certain amount of remuneration for the use of the cemetery; but the expense of fuel would not amount to more than a few shillings. This was cheaper than a common burial under the present system. At Ilford 9000 people were buried every year, and as the Commissioners of Sewers of the City of London had found the present system a very expensive and dangerous one, they had now taken up the question of cremation, and although the report of their Sanitary Committee had not yet been adopted, he had every hope that it very soon would be. It had been urged that the present objection to the system of burial was due rather to the abuse of the system, and that if the dead were properly buried in earth in wicker baskets the danger would be small; but he believed the danger would be thereby increased, owing to the rapid decomposition of bodies. Having buried a pony in a loamy soil, over clay, the sight after three years was most shocking, and any one who had seen it and compared it with the result of cremation would certainly prefer purification to putrefaction. It was imagined that the clergy of the country were against cremation, but so far from that being the case, many clergymen had spoken in its favour,

among others the Bishop of Manchester. If clergymen could only be convinced that the burning of bodies would restore burial in churches or around churches or in crypts underneath, and that the ashes might be preserved as a monument in the church, by which means the association between the family and the church would be restored, he thought the system of cremation would soon become almost universal.

Dr. FARQUHARSON, M.P., thought they should take every means in their power to form a healthy opinion upon the subject of cremation. In discussing the matter sometime back in the House of Commons they were twitted by Sir William Harcourt that they had not at their back public opinion. Sir William Harcourt treated the subject in a very light and airy fashion. He put down his foot and thought by that process he had crushed out the question of cremation for ever. No doubt when he came to look at the division list next morning and found that in spite of his side being backed up by Government tellers they had 70 members who voted in favour of the measure, and that the public press almost unanimously supported the movement, he must be sure that there was a good deal more public opinion at their back than he supposed. The growth of opinion upon this subject was very rapid indeed, and having been in communication with many people upon this subject he knew that the general opinion was one of regret that the bill had not been passed. The first difficulty against the scheme was that of prejudice, and then the difficulty of self-consciousness of which English people had such an enormous quantity, and then came Mrs. Grundy; because in this country no one was allowed to do what was right and proper, but merely what other people thought was right. When they had shaken themselves free from that state of things, which would come about after a healthy period of discussion, then these matters would become common-place things of the day, and they would be surprised that they had not been adopted before. He was sure that it would require some little pluck to be cremated at

the present moment—by that he meant it would require some amount of pluck to leave a specific direction behind that after death his body was to be cremated, because he would know that his relations would have to face a good deal of difficulty. He thought they were immensely indebted to Mr. Eassie for having taken the affair out of the region of mere theory and shown practically how the thing could be done. He had seen with very great interest how very clean, rapid, and successful the plan was, and he was sorry that they had not had the opportunity that afternoon of seeing the ashes of half a horse which had been burnt in the crematory. If Mr. Eassie had given a practical lecture he would have carried the whole of the audience with him. Now it was extraordinary to reflect how the matter really stood. They were told that cremation was not legal, but it had already been accomplished, and the law was powerless to prevent it, though there will still be many excellent people who would not go in for a thing of this kind unless it had the full and absolute sanction of the law. He quite agreed with Dr. Cameron in thinking that it was an extraordinary thing that the Government should come forward and interfere with people being buried or consumed in exactly the way they pleased. Some people liked to rot slowly in the ground, and to be eaten by worms, which was certainly a most disgusting state of affairs; but that was no reason why other people should not be consumed quickly if they wished to be. The objection raised by Sir William Harcourt was, that the bill was only permissive, but if the bill was permissive it cut away the argument that you might be poisoned, and cremated in order to destroy all trace of the crime. He thought instead of encouraging crime it would go far to prevent it in a very great degree. They must keep on pegging away at the subject, and as Dr. Cameron was as keen as he was able, he had no doubt he would bring in another bill next year when they would have, he thought, a still better division than they had before, and he hoped on that occasion to have the pleasure of rubbing

shoulders in the division lobby with their noble Chairman.

The Rev. BROOKE LAMBERT was strongly of opinion that those who opposed the idea of cremation on the ground of religion were not worthy of being listened to. It was very curious that this subject of cremation was taken up 225 years ago by a most religious man, namely, Sir Thomas Browne. He was very glad to be able to testify to what Dr. Farquharson had said about the growth of public opinion, for some ten years ago, when he introduced the subject of cremation into a Midland town, an amount of public opinion was raised against him, for which he was quite unprepared. He was thankful to say that public opinion, however, was changing, and having been preached at upon that occasion by the Bishop, he was thankful to know that if he now lived in the diocese of Manchester he would have a Bishop who would have most cordially supported him in the belief which was held now by many earnest men. It was strange how any one could think that there was anything contrary to religion in cremation. If it was supposed that the actual carcases of the individuals were their title deeds to resurrection, then they must come to this extraordinary conclusion that the martyrs, who of all men in the world were supposed to have the best right to resurrection, were the very people who happened to have lost their title deeds. If people in the nineteenth century could possibly believe the nonsense about its being necessary for the actual remains to stay in one place in order to be sure of resurrection, all he could say was that in the next world they would have a most extraordinary exhibition at the day of resurrection. The population of heaven would be an aristocracy or a plutocracy, for only people who could afford vaults or brick graves were sure of having their remains undisturbed. It was almost impossible to argue seriously upon this particular ground. Those who objected to cremation on religious grounds were people who had really not thought at all about the subject. It was interesting to know that long

before the subject was publicly talked about, such a man as Southey had written about the "nasty custom of interment," and thought that burning would be much better than the corruption of the grave. Cremation was only doing in a quicker way that which was done slowly by decay in the earth, and doing it without causing harm to the living, and if this fact was remembered many more would be on the side of cremation. It was merely a question of how far public opinion could be influenced, but having truth upon their side he thought they must win in the long run.

Dr. BARTLETT said, as the last speaker had taken his stand upon religious grounds he would endeavour to confine himself as nearly as possible to the chemical aspects of the question. Some years ago he took a house in the neighbourhood of Norwood, which had been occupied by one gentleman after another as a country house for more than fifty years. Previous to that the house had been used for a boarding-house for infants from the infirmary and the workhouse, and many of their bodies were buried in the garden. Shortly after he took the place the garden was deeply trenched, they came upon these remains, and a considerable amount of illness was the result. If it was true of the ordinary method of burial, why should they object to a more rapid method of dissipating all that was noxious in the remains. It was very well known that the ordinary overcrowded graveyard was nothing more or less than a focus for disseminating disease. All the records proved that disease was more rampant in the neighbourhood of such graveyards than elsewhere. Burial was merely a retardation of the process of decay by which possibly the germs might become extinguished in the lapse of time; but such things had happened as the bursting of a leaden coffin by the pent up gases within, and when this occurred vaults were nothing more than centres for the retention of disease. Another system of burial in which decomposition was highly diluted was burial at sea. There could be no particular objection to that method; and it had been proposed that funeral steamers should

be chartered for the purpose of the disposal of our dead by taking them out a sufficient distance to sea and casting them into the deep. The fanciful objections to this plan were equally liable to be cast against cremation. According to the proposals of Dr. Cameron, what was intended to be done was to have every possible safeguard to prevent persons whose cause of death had not been well ascertained from being committed to the flames. Independently of the large number of those who were committed to the earth without proper certificates, there were many who were buried in the ordinary way who did not die from the diseases appearing on the certificates. It had been his duty on more than one occasion, where murder had been suspected, to examine the bodies some time after interment, when he found that the cause of death was very different from that which appeared upon the certificate, and traces of poison were found. If those bodies instead of being buried had been cremated, the cause of death would at once have been detected, because before being burnt the body would have been subjected to a medical examination. He did not mean to say that many persons were poisoned, although there were far more cases of wilful poisoning than they had any record of, but what he did say was this, that death resulted from the taking of poison wilfully or through accident, and the bodies were buried without any means being taken to prove whether the certificate was properly given. Whatever dangers from disease resulted from the decomposition of bodies in the earth, much benefit must accrue from taking the body away as soon as possible after death occurred to the proper mortuary chambers, which were associated with crematories. This would form not only a means to the end, but would prevent Irish wakes and the foolish English sentimentality by which so many persons follow a corpse to the grave. If cremation destroyed the germs of disease, and prevented the possibility of disease occurring after the lapse of thirty years, these were safeguards which should commend themselves to every one who does not merely regard the sentimental aspect of the

case. Some regard should also be given to that which was the basis of the Conference, and however much they might object from mere sympathy of ideas of times gone by, he thought they must believe that cremation was the healthiest method for the disposal of the dead.

Dr. PRINGLE said, having served with Her Majesty's Army in India for many years, he had perhaps seen as much of cremation as anyone. With regard to the religious question, it was supposed in India that it was necessary to pass through the fire in order to become purified. One objection to burying the dead was that in India there was a small animal which opened up graves, and these holes were enlarged by other animals who devoured the bodies. The sooner something was done to try and protect the living the better, and there could be no better place than the Exhibition for the discussion of such an important question.

Capt. DOUGLAS GALTON said the subject of the Paper was, "The disposal of the dead," but most of the speakers seemed to have limited the discussion to the subject of cremation. No doubt cremation had many advantages, but it would be a very long time before it was universally adopted in this country, and therefore as sanitarians it would perhaps be desirable to give a little more attention to some very interesting points mentioned by Dr. Blyth in his Paper. It was most desirable that there should be a very large increase in the number of mortuary chambers in the different towns, and that it should be the absolute rule that no dead body should be allowed to remain in any house unless there was ample spare room in which it could be placed entirely apart from the inhabitants. That was the more essential now as they were occupied in London in building large blocks of industrial dwellings. Every one of these blocks ought to have in some part of it a place allotted, where bodies could be placed instead of leaving them in the rooms. No doubt there were other questions which Mr. Blyth had introduced. For instance, that of embalmment. It was a point deserving of serious consideration, whether persons who were found

dead in the street, and not identified, should be subjected to some preservative process, in order to facilitate identification. After the French War of 1870 a very interesting experiment was made, an immense number of people killed at the battle of Sedan were buried very hurriedly, and it became necessary a year afterwards to proceed to some form of disinfection of the neighbourhood, and on uncovering the bodies it was found that all buried in clay had been perfectly preserved, whereas those in more open soils, such as chalk, had in some instances entirely disappeared. Those were points which so long as they retained the present burial-grounds should receive careful consideration. Sir Spencer Wells said that the soil from a burial-ground was scattered over a particular surface, and that an attack of scarlet fever took place, which was traced to the burial of persons who had died of scarlet fever thirty years before ; but unless there was some very strong evidence to show that it was the cause of the epidemic he thought it was a very unfortunate thing that a man of Sir Spencer Wells' eminence should make such an announcement as that diseased bodies buried for thirty years would reproduce their diseases.

Dr. DUDFIELD was glad to find that the religious and sentimental objections to the practice of cremation were so far on the decline that there was a chance of the question getting a free and full discussion, and of its being settled on the merits in the not far distant future. There were many objections upon sanitary grounds to the present system of disposing of the dead, some of which were more or less avoidable. Reference had been made to the pollution of springs, and it was a notorious fact that no water was more pleasing to the eye and pleasant to the taste than that obtained from wells near churchyards, and it was extremely probable that disease had been spread to a great extent by the use of such water. At the present time people did what they liked with their dead prior to burial, irrespective of the question of whether they were doing an injury to the living. The poor lived whole families in one

or two rooms each, and dead bodies were often allowed to remain in such rooms for many days together, the results being sometimes disastrous. What was wanted was the compulsory burial of bodies at an earlier date, and a law compelling their removal to a mortuary when there was not proper accommodation at home. It was a fact that poor people had been so confined as to space as to be obliged to make use of the coffin as a table. There was no doubt that the dead were a source of danger when death had been caused by infectious diseases, and outbreaks of small-pox in the east end of London had been clearly traced to the holding of wakes. He had known undertakers contract small-pox from the dead. As to the burial of bodies in leaden coffins, in vaults, he did not think it was by any means a satisfactory arrangement, though if the body were embalmed there would be no particular objection to it. When the coffin of King John was opened at the end of 500 years the body was found intact, though directly the air came to it it fell to dust. Probably it had been embalmed. The gas given off by a body undergoing decomposition could burst a leaden coffin, so that there was no security from this system of burial. With regard to the physical act of cremation, he might touch upon the Contagious Diseases (Animals) Act, under which it was the duty of the Metropolitan Board of Works to provide for the destruction of the bodies of animals dying from certain diseases. Sometimes this was done by boiling the body, as in the case of glandered horses. In the case of rinderpest the bodies of cattle had been buried. This, at any rate, was not destruction at all, although the Act said the bodies were to be destroyed. Worms went down a great depth and brought up bacteria, and so the disease had been spread. He ventured to suggest to their honourable chairman that the Metropolitan Board of Works should establish a crematorium for animals dead after infectious diseases; they did their work so well that cremation would doubtless arrive at great perfection under their management, and the public would in time become familiarised with the practice.

Dr. ALFRED CARPENTER said he might mention one fact in order to show how necessary it was that something should be done in the direction indicated. That morning an outbreak of pleuro-pneumonia had been reported to the local authorities at Croydon, which to his official knowledge had happened for the third time in that particular set of cow-houses, though he happened to know from his own knowledge also that it had broken out five times in the same place in the course of fifteen years. Of course, cattle dying from this disease had to be buried in the ground where they died, and the cause of the present outbreak was, he felt certain, due to the material which was preserved in the ground. With regard to infectious diseases amongst human beings, as well as animals, whilst he was not prepared to go to the utmost length of saying that the time for cremating all bodies had arrived, he did think that where they died of infectious diseases the process of cremation should be encouraged. It was possible for the germs of disease to be preserved by the very means that were taken for the disposal of the dead, and therefore for the sake of the living it was right that that process should be altered.

Mr. LIGGINS, as a protest against the views which had been expressed by so many gentlemen upon the subject of cremation, begged to say on behalf of himself and millions of persons outside the room that cremation was a process which ought not to be adopted for the disposal of the dead. For 1884 years their forefathers had not been quite the fools they took them to be. Man came of earth and to earth he should go. As to the statement which had been made that people were taken to their graves without a certificate from a medical man, all he could say was that the member of Parliament who made that statement should have taken some steps in Parliament upon the matter.

Dr. GIBBON objected to scientific opinions going forth from that meeting that dead bodies disseminated disease except in the case of small-pox. With this one exception all the facts went to show that the disease and the body *became extinct* at the same moment. It had been stated

that health had been injured by people drinking water from wells near graveyards, but no evidence to prove that statement had been, or could be, brought forward. Cremation was an attempt to improve upon nature. Nature disposed of her bodies in the earth, and the earth which had grown was entitled to receive the dead bodies. He had buried the dead bodies of animals and covered them over with a thin layer of earth as well as with charcoal, and found that earth was nearly as efficacious as charcoal in preventing any smell rising therefrom. He suggested that the experiment of using earth over dead bodies should be tried by the Cremationists. He thought the public had been rather deluded as to the disinfecting deodorant and absorbent properties of earth, and gave it as his decided opinion that a little earth spread over burial-grounds would prevent all fear of infection. There was no evidence to support the allegation which had been made, that disease was contracted in burial-grounds; on the contrary, he could testify that London children had been benefited in health and strength by being allowed to frequent Bunhill Fields, St. Pancras, Marylebone, and other crowded burial-grounds.

Mr. HODGSON thought there could be no possible doubt that the practice of crowding graveyards was conducive to the injury of the health of the living. They were all greatly indebted to the labours of the Cremation Society in attempting to educate the people of England to the great effect which would be ultimately derived from their recommendations, though no doubt they would have to persist for many years before the general mass of the public were converted to their views. The time would come when cremation would be allowed, and, very possibly, during the lives of many of those present. Until the system came into operation, it was for them to consider what further precautions might be taken to protect the living against the corruption of the dead. One or two gentlemen had stated that interment in vaults and leaden coffins was the most perfect from a sanitary point of view, and no doubt this was

true if the coffins were of sufficient strength and were soldered down so that the gases were confined. He would suggest that one of the most effective methods which could be adopted was to place the body in the coffin in the ordinary way and to fill up the coffin with Portland cement. If this were done it would be quite impossible for any kind of gas to escape.

Mr. SMITH inquired whether it would not be possible, through the instrumentality of influential gentlemen in this city, to obtain the patronage of the highest in the land to the plan now proposed for the disposal of the dead, because he thought if this could be done it would be a powerful element in converting the mind of the public.

The CHAIRMAN said he did not know what the general feeling of the meeting upon the subject was, but his own feeling was that he should leave the room after what he had heard with a sense of creepiness over him that would not go off for many days. He fully and entirely agreed with the desirability of having mortuaries, and he thought it would be a good thing in large artisan dwelling blocks to have some place where the dead could be placed. That might be done with very little trouble. With regard to diseased animals, the Metropolitan Board took the best means at their disposal for the removal of the bodies, and he was not in a position to give any pledges as to cremation. In conclusion, he begged to move a hearty vote of thanks to the Joint Committee of the Society of Medical Officers of Health, the Sanitary Institute of Great Britain, and the Parkes Museum of Hygiene, for having organised these Conferences. The subjects which had been discussed that week were of great importance as affecting public health, and the gentlemen who had taken the trouble to arrange the Conferences were deserving of thanks.

The resolution having been carried unanimously, was acknowledged by Dr. Dudfield, as Chairman of the Joint-Committee, who congratulated the three Societies on the complete success of the Conference. He also proposed a vote of thanks to Sir James M'Garel-Hogg for pre-

siding. Sir James, he said, as Chairman of the Metropolitan Board of Works, held a representative position, that Board being composed of delegates from all the Sanitary Authorities of London and in that capacity he had been invited to open the Conference, the honour of closing it having been intended for himself. Sir James, however, was not in England at the time, and he very kindly consented to preside at the final meeting, and so the duty of opening the Conference had devolved upon himself. Sir James' absence from the first meeting was cause for regret, because he could have spoken with so much authority on the subjects of the papers read on that occasion, relating as they did to domestic sanitation and sanitary administration in London, whereas he confessedly was not at home on the subject of cremation. The vote of thanks having been carried by acclamation, the proceedings of the Conference terminated.

ST. JOHN AMBULANCE ASSOCIATION.

CONFERENCE ON MONDAY, JULY 21st, 1884.

THE CARRIAGE AND REMOVAL OF THE SICK AND INJURED.
THE AMBULANCE ORGANISATION OF THE METROPOLIS DURING EPIDEMICS.

ST. JOHN AMBULANCE ASSOCIATION.

CONFERENCE ON MONDAY, JULY 21, 1884.

Sir JAMES PAGET, Bart., F.R.S., in the Chair.

SUBJECTS FOR DISCUSSION:—

1. "*On the Carriage and Removal of the Sick and Injured.*" By JOHN FURLEY, Esq.
2. "*The Ambulance Organisation of the Metropolis during Epidemics.*" By V. B. BARRINGTON-KENNETT, Esq., M.A., LL.M.

ON THE CARRIAGE AND REMOVAL OF THE SICK AND INJURED.

By JOHN FURLEY, Esq.

AT a time when the International Health Exhibition forms a very important centre of attraction, the moment seems opportune for some remarks on a subject to which much attention is being directed, namely, ambulance transport material and its proper employment.

Until within the last ten or twelve years, the word "ambulance" was almost unknown in this country except in connection with the Army Medical Service; but in 1870–1, through the efforts of the National Aid Society, more familiarly known as the Red Cross Society, it was so generally adopted in our language that it is now as much

misapplied as formerly it was little used. People who are accustomed to think of invalid carriages, hand-litters, and stretchers as "ambulances," would be rather astonished to learn the War Office definition of an ambulance and all that it comprises in men, horses, carriages, medical and surgical stores, and camp furniture.

I confess to a great feeling of disappointment, and I know this is shared by many who take a keen interest in the subject, that the Ambulance Department in this building is so far behind what we had a right to expect from the displays which have been witnessed in Paris, Berlin, Vienna, Brussels, and elsewhere. The International Health Exhibition is a most amusing and interesting collection of objects, more or less connected with hygiene, surgery, and the art of living, and I sincerely trust it may prove to be as successful as its promoters can desire. But where is the ambulance section, British or Foreign? Can any one seriously pretend that the few vehicles, surgical appliances, and models which are to be found scattered about amidst costly and luxurious chairs, couches, beds, and perambulators at the end of the Belgian Annexe, fairly represent the progress which this country has made during the last few years towards perfecting ambulance material, or convey an adequate idea to the uninitiated mind of what our Army Medical Department can do, and is doing, in every part of the globe for the health, care, and comfort of the British soldier? I venture to assert that the failure of the display in this respect is due in a great measure to the cause to which I have already referred—the misapplication of the word "ambulance" and the ignorance that still prevails as to what it really means.

Having thus parenthetically relieved myself in a manner which I hope will not be misunderstood by those through whose kind courtesy I am permitted to address you to-day, I will at once turn to the subject of ambulance work in the United Kingdom, and more especially in reference to what has been done within a very recent period towards systematising the carriage and removal of the sick and injured.

It is not my intention to describe or to criticise the

Army Hospital Organisation; indeed, it would be an impertinence on my part to do so, and I shall only incidentally refer to this important branch of the public service.

I am convinced that there is a perfect community of sentiment between doctors who are engaged in civil practice and those who hold commissions in the Army and Navy: all are alike animated by one earnest feeling of loyalty to the distinguished profession to which they belong, and of generous devotion to the interests of that public to whose service they have dedicated their lives. So with the individuals of all ranks who work with and under them, there is but one desire, namely, to do their duty, it matters not in how humble a capacity, so long as the object is the alleviation of pain and suffering, in peace or in war, in the street or on the battlefield, amid the din and excitement and all "the pomp and circumstance of glorious war," or the daily routine of hospital work, or in the remote recesses of a coal-pit, far from the sight of approving witnesses.

In general hospital work Great Britain is on a level with, and in many respects in advance of, any other country in the world. The magnificent establishments dedicated to the relief of suffering humanity, which are scattered over the length and breadth of these islands, afford ample proof of the liberality of the founders and of those who continue to support them. Nor does this sentiment exhibit any degree of diminution. Many circumstances have changed, and medical skill is more evenly distributed than it was fifty years ago. There is now less disposition to enlarge existing institutions than to establish others. Cottage hospitals have exercised a most beneficial influence, for they have enabled doctors to keep under their own care a large proportion of cases which formerly, and often at great risk, were taken from them; thus, independently of the benefit to the patients, the whole community has derived advantage; in the first place, by the practice allowed to the surgeon's skill, which he was often in danger of losing from want of opportunity, and secondly, by the field which has been opened to people of all ranks for closer contact

with physical pain and suffering, and for the free exercise of their best and most generous sympathies.

But whilst much care and attention have been bestowed on the internal economy and hygiene of hospitals, comparatively little thought has been given to the manner in which sufferers are conveyed to them. In this respect, perhaps, we are behind some other nations.

What the National Aid Society accomplished in 1870–1 belongs to history. England was slow in following the example which had been set by other States, but the British Red Cross Society, when occasion called it into existence, gained in a few weeks a position second to that attained by no other country, not excepting the two powerful belligerents who then occupied the arena upon which all eyes were directed. What the St. John Ambulance Association has done during the last six years will fill a no less important page. This differs from the National Aid Society in one particular, that, whilst the latter followed, in its own vigorous and practical manner, examples which were the result of carefully matured thought and experience, the St. John Ambulance Association was a new creation, and no better testimony in its favour can be afforded than the fact that it has already been imitated in every part of the world, with more or less success, and notably by an institution which was originated at Kiel, by Professor Esmarch, and is now flourishing in Germany under the title of the *Samariterverein.*

It is worthy of remark that, as at the time of the great war which called the National Aid Society into existence, civilians and soldiers were blended in one common object, so the greatest harmony has since united them in the endeavour to extend ambulance work for peaceful purposes. Much mutual advantage which, as I believe will be greatly developed in a not remote future, has already resulted from this interchange of ideas and experience.

Peace and war are represented in this country by the two societies to which reference has just been made, but henceforth their aims will not admit of separation; dis-

tinct as may seem the two fields in which the members respectively labour, it is not the less true that it is from the *personnel* which is trained to relieve physical suffering on the battle-field of daily life, we must draw that efficient supplement which will inevitably be required by the Army Medical Department for any great war in which we may be engaged; and it is from the experience gained in the rapid improvisations which are incidental to military surgery and army transport, that so much may be learned by the civilian.

In this union there is nothing inconsistent with the principles of the most devoted adherent of the Peace Society; but, on the contrary, he will be driven to admit that much of that training, uniformity, and discipline, which were formerly limited to military requirements, are of the first necessity to those who desire by means of organization to minimize physical suffering.

In the first hours after a great battle, or in the accidents of civil life, there is no more valuable knowledge than that which enables a man to improvise surgical appliances from anything he may find at hand: it is useful to the surgeon, and makes for him ready assistants in others. We know how often doctors are compelled to have recourse to their own resources when ordinary mechanical means are wanting, but until quite recently the general public have stood aside, unable to offer them any assistance, or at the best seeking instruction at the very moment they should have been able to apply knowledge. But a great change has taken place, and the medical profession is the first to acknowledge it, especially those of its members who have voluntarily given instruction in the first and simplest rudiments of their art to classes of men and women in districts where serious accidents are frequent, and often widely disastrous in their effects. Were it necessary to produce specific proof of this change, a volume might be filled with a record of the results which have followed on five years' instruction in the method of rendering first aid to the sick and injured; and a large proportion of this evidence is so much the more

trustworthy as it comes from doctors who are independent of the professional instructors and examiners, and, in not a few cases, from those who were at first opposed to the ambulance movement as an unnecessary and possibly a dangerous innovation.

Contrast the conduct of men in the Metropolitan or City police, when an accident now occurs in the London streets, with the manner in which the victim of a disaster was formerly handled and carried to a hospital; or watch the intelligent way in which a police constable in a country village now endeavours, pending the arrival of a doctor, to restore animation in a person apparently drowned. See how promptly a fireman steps aside in the midst of a conflagration to succour a comrade who has been crushed by a falling beam. Go into a large ship-building yard in Middlesborough and note how, on the first alarm of an accident, men who have earned their "First Aid" certificates will quickly arrive on the spot with a hamper of necessary appliances and a two-wheeled litter, on which the sufferer will be carefully and rapidly wheeled to the hospital, after the first temporary remedies have been employed. Land with a boat's crew on some inhospitable shore, and when a limb is broken, or a man has sustained a gun-shot wound, judge for yourself whether time bestowed by the ship's doctor on the instruction of the sailors has been well spent. Or take the evidence of an officer lying in his bed at Malta whilst he tells you how, under Providence, his life was saved at Tel-el-Kebir by one of his men who had attended a course of ambulance lectures in London. Enter a house, furnished with every comfort and luxury: a mother is compressing an artery in the arm of her only child whose pale face gives assurance of the inevitable fate which awaits him should the nerve of his loving parent fail but for an instant. The doctor comes, and that life has been saved. A railway accident is reported at a station where an ambulance class has been held, and where the porters and other employés occasionally meet for the purpose of practice. See how well they act together,

and how intelligently they use the First Aid material and stretchers, which they now keep always at hand; and, when the doctor arrives, listen to his opinion as to the services of his humble assistants. Descend to the deepest working of some of the coalpits in Derbyshire, Durham, or Yorkshire, and when an accident happens, as unfortunately they do so frequently happen, look at the way in which a tourniquet will be made out of a knob of coal, a strip of calico torn from a shirt, and a hammer, and splints will be improvised from any tools that may be at hand: tenderly and laboriously the crushed miner is borne through the low and narrow windings of the pit until he can be put upon a stretcher and placed in the cage, and thus raised to the mouth of the shaft: here the doctor is waiting, amputation is inevitable, but he finds the extemporised tourniquet so well adjusted that it is unnecessary to exchange it, and the mangled and useless limb is taken off without any further loss of blood.

These are not imaginary instances, but they are examples of daily occurrences. There is much more to be done, indeed the work is never ending; but the above sketches are a few typical records of the modest results accomplished during the last five years, of which instructors and pupils may well see cause for mutual congratulation.

Attention having once been directed to the general ignorance which until lately prevailed as to how to act for the best in cases of sickness or accident, it was not long before consideration was almost insensibly drawn to the insufficiency or complete absence of proper means of hospital transport. The chief reason why, in this respect, we were much behind some other countries is to be found in our insular position, which has saved our native soil for so long a period from the presence and even the contact of war. There is not another country in Europe which has not during the last thirty years been more or less directly influenced by the realities of war, for all, if they have not suffered from its actual presence, have without exception felt its cruel blast upon their frontiers. As a consequence

of this experience, other nations have more fully realised that saddest part of war, the dead and the wounded scattered over vast battle-fields, the dressing stations where temporary relief is given, the field hospitals, and the long columns of wagons bearing hundreds of maimed men to the base of operations. All this and much more than it is necessary to describe in detail have, in a great measure, familiarised other European nations, and the United States of America, with military ambulance material and its uses, and civilians have vied with soldiers in the endeavour to keep the means of saving life and alleviating the sufferings of the wounded on a level with those means of destruction which military skill and scientific knowledge are ever striving to bring to perfection.

The Exhibition held in connection with the Red Cross Conference at Berlin in 1868, the important Ambulance Department of the International Exhibition at Vienna in 1873, the Hygienic Exhibition at Brussels in 1876, the Red Cross Exhibition at Geneva in 1882, the Grand Exhibition at Berlin in 1883, and the frequent meetings which have been held in Paris under the auspices of the *Societé de Secours aux blessés militaires* have given great encouragement to this feeling, and much practical advantage has been derived from the trials and comparisons which were made of the means of hospital transport adopted by various nationalities. But in England no similar advantages have been enjoyed, and the number of surgeons and laymen who have taken part in these experiments is very limited. Had the ambulance group of exhibits in the present Exhibition attained that standard which continental critics might have expected, the fact would have been evident that we are beginning to realise our shortcomings, and we might have satisfactorily proved by demonstrations that we are not only taking lessons from the Continent of Europe and the United States of America, but that we are striking out paths of our own towards results which must have a world-wide influence.

I may again observe, that the public having once ap-

preciated the advantage of having practical instruction in the most elementary rudiments of anatomy and surgery, and in the simplest manner of affording assistance in cases of sickness and accident in order to avoid those mistakes which, in the absence of a doctor, were, and are still, so prevalent, thus aggravating or complicating physical disorders and the results of accident, it was not long before people began to recognise that our means for the conveyance of invalids were lamentably deficient. As an important preliminary it was necessary to emphasise the fact, that it is much better to know how to extemporise stretchers and ambulance carriages than to trust to carefully-devised mechanical appliances, for the latter can never be sufficiently distributed to meet all contingencies.

Until quite recently, with the exception of those used in hospitals, the majority of the stretchers in use combined primitive simplicity with weight and clumsiness to a degree which would be unintelligible in the present day, if it were not that there are plenty of specimens of the same type still to be found at police stations and union workhouses; a rigid wooden frame with canvas stretched over it, and iron legs, was thought to be the *ne plus ultra* for the conveyance of persons injured by accident or suffering from drunkenness, and for the latter class strong straps and buckles afforded additional security. Those whose duty it was to carry those stretchers generally bore them on their shoulders, thus, besides requiring four bearers instead of two, adding another source of danger to that which had been already incurred by the patient; and they marched in step, if they knew how to do so, and therefore according to modern notions it was better when the bearers were undrilled men. For such means of transport a narrow doorway or an ordinary staircase was a formidable obstacle which could only be overcome by taking the patient from the stretcher, no matter what his condition might be, an alternative generally productive of increased suffering and frequently of more serious results.

No person who has not endeavoured to design a new stretcher can have any idea of the difficulty and even impossibility of inventing one equal to all requirements. There is the hospital stretcher, which must admit of the framework being withdrawn, thus leaving the patient on a bed or an operating table with only the canvas intervening. Then there is the military stretcher, which must have feet, and yet be made to fold into small compass without any diminution of its strength. Again, there is the stretcher for general civil purposes, to which, for police use, strong leather straps only need be added. With the exception of the hospital stretcher, there is one rule applicable to every other variety; it is indispensable that there should be no independent parts, not even a detached pillow, otherwise there will always be the risk that one piece will be missing when most wanted. As far as the demands upon it will allow, the St. John Ambulance Association has also endeavoured to introduce uniformity of size in the stretchers it has issued, so that when they have to be put into road or railway carriages there may be no mistake as to the capacity of the vehicle to take them. For military or police use it is perhaps not yet possible to have stretcher handles that can be shortened at pleasure, though undoubtedly we shall arrive at this improvement, and thus lessen the length and weight of our Army Hospital wagons. For all other purposes such an arrangement is frequently found to be a great convenience, especially in narrow and winding passages and staircases.

Much advantage has also been found in adapting ordinary stretchers to wheels and covers, thus forming a two-wheeled and covered litter, which is very useful for short journeys. Without shifting a patient from the stretcher, this litter can also be sent long distances by road or rail in cases where the journey has to be broken, or there may be a difficulty in obtaining a suitable vehicle to take the stretcher at the end of the journey.

From the hand litter, or stretcher on wheels, the advan-

tages of which have been fully recognised during the last three years, we next come to the horse ambulance carriage, about which there is much diversity of opinion.

Undoubtedly, if proper vehicles can be obtained, it is better in most cases to wait for them, although at the sacrifice of a little time. But unfortunately, even in some of our largest towns, one might look in vain for a satisfactory stretcher, or a fairly comfortable ambulance carriage, and the public cab, or the disused fly, converted by parochial parsimony into an invalid carriage, are still considered by too many bodies of guardians as quite good enough for broken legs or injured spines, or for the patient, the cause of whose insensibility has not been determined, and who being unconscious may be doubled up with impunity! How few towns possess adequate means for the removal of such cases! and when the subject is discussed at municipal councils, or by other local authorities, the vote, for the sake of a cruel and mistaken economy, is generally in favour of making any carriage do for the sick and injured rather than have a special vehicle constructed for the purpose.

It could not be publicly asserted that ratepayers would oppose a moderate expenditure for such a humane object, because it is well known that if properly put before them, they will insist on an outlay which is so obviously for the benefit of the whole community. The public purseholders are therefore driven to find another excuse, and we are told that it is not advisable to have specially constructed ambulance carriages, as such vehicles advertise themselves, and frighten people, and for this reason it is better to have a converted brougham or a street cab. If this be true, which is doubtful, the sooner the public are educated to discern the proper means of conveyance for invalids the better it will be for them, especially as the knowledge will bring with it an increased respect for such vehicles, more sympathy with those who have to occupy them, and greater facilities for their uninterrupted passage through crowded streets.

There is, perhaps, another question involved, namely, the possibility of a belief that an ordinary accident carriage might be used for patients suffering from infectious diseases. This is also a matter which should be boldly and honestly met, and the public will soon learn that the two classes of invalids are kept quite distinct, and that no vehicle used for small-pox or fever patients, is kept in the same place, or is worked by the same staff, as those which are employed for accidents and non-infectious cases.

Whether is it better to allow persons suffering from infectious diseases to go in cabs and omnibuses, as they frequently do, in order to make application for admission to hospitals, or to have special vehicles of two classes for their use? Those who have any experience of the poorest districts in our large towns know how necessary it is that some such arrangement should be made, in order at once to put a stop to an evil from which rich and poor alike suffer, but the blame for which cannot be attributed to the latter. If we would stamp out disease in its earliest stage, every opportunity should be afforded for doing so in an open and honest manner, and the sight of a fever-carriage worked on this principle would soon inspire confidence rather than dread, for the public would learn to appreciate the fact that it is better an infectious patient should be immediately removed from their midst under proper precautions and guarantees than be allowed to be a source of danger to others.

My friend, Mr. Barrington Kennett, will presently, I believe, give some interesting details as to the system which is now being worked by the Metropolitan Asylums Board, and he will probably tell us of the difficulties with which he and his colleagues have to contend in overcoming the objections which are raised to the sight of an ambulance carriage, even when it is known that the vehicle is employed in preventing a patient from being a positive danger to his neighbours. This part of the subject, therefore, I prefer to leave in his more competent hands.

Improvement in ambulance material can never be accom-

plished by theorists, but it must be gradually brought about by actual work and experience, and by those who are willing, notwithstanding disappointment and discouragement, to perform yeomen's service in the cause. We may have the best carriages, littêrs, stretchers, and other things necessary for the transport of invalids, but these are of small importance compared with the advantage of having intelligent trained men to use them.

I would have willingly avoided intruding my own personality upon your notice, but had I done so, this paper would not have the slightest claim to your attention, as it is only individual experience that can give a weight to arguments which otherwise would be absolutely without value.

I have spent a considerable part of several years in perfecting to the best of my ability, with the assistance of practical workmen, the simpler forms of vehicles, such as stretchers and litters; but I could not stop here, and I have lately ventured to introduce a few horse carriages to public notice. This step was an ambitious one, for I had no support in a single-handed contest, and I was unable to do all that I knew required to be done. After a struggle of nearly two years, a generous friend commissioned me to furnish him with a capacious ambulance carriage, and he presented this to the St. John Ambulance Association.

I also had one built, of somewhat similar pattern, for the Northern Hospital of Liverpool. This, I believe, to be the first vehicle which has been worked in this country on the American ambulance plan. The station where it is kept is in telephonic communication with all the police offices in Liverpool; the American clip harness is employed, and I am informed that the average time taken to get out the carriage fully equipped is under two minutes. Within the first eleven months' existence of this new establishment, there were 476 calls for the carriage, thus proving how much such an organization must have been needed. Carriages of the same type are now in use in other places, but I have referred to the two most salient

examples of such vehicles used in this country, one at short notice for accidents, the other for the removal of invalids from one place to another, where time is of less consequence.

I should like to speak of ambulance carriages invented by other persons, but I refrain from doing so, because, fully conscious as I am of the faults in my own, I should be sorry to say one word which might seem to disparage the efforts of others. As inventors, we may mutually congratulate ourselves that we have all done something, even in our mistakes, for the public good ; and I personally take this opportunity to express my gratitude to friends in London, Liverpool, and elsewhere, who have given me real support in a difficult undertaking ; they not only have my most cordial acknowledgments, but they deserve the thanks of the public, for having boldly and generously assisted in striking out new paths of usefulness, and offering the results of their experience for the benefit of the whole community. Taking but one example, I venture to assert that if the Committee of the Northern Hospital of Liverpool were compelled to sacrifice their present ambulance station and its contents, and begin the work *de novo*, the money and time they have spent would not be lost, for they have not only diminished the sufferings of some hundreds of persons, but they have set an example which, whether followed in whole or in part must prove of great advantage throughout the country.

The use of specially constructed ambulance carriages will become general, and therefore I would insist on the necessity of maintaining, as far as possible, uniformity in the general arrangement of these vehicles, and the stretchers to be employed with them. As an illustration of the advantage of such uniformity, I may mention that a few weeks ago an invalid at Cannes was placed in a compact bed, on an "Ashford" litter, that had been purchased of the St. John Ambulance Association for use in that town, and taken to the railway station. Here he was lifted off on the stretcher and put into a saloon carriage, and thus brought without change to Boulogne. Patient and stretcher were then put on

board a steamboat, and at Folkestone again placed on the railroad. Two members of the Metropolitan Ambulance Corps of the St. John Ambulance Association, met the train at Charing Cross with a horse-carriage, and in this manner the invalid was transported, literally in a bed, from the shores of the Mediterranean to his home in London. I could cite many instances of the manner in which persons of very limited means have been moved from one part of England to another, but I have taken one case which will best prove that there is no limit to this special work of a corps which is unostentatiously doing its utmost to improve the present unsatisfactory means for invalid transport.

Having mentioned one example of the removal of an invalid a long distance by land and water, I would say a few words as to the formation of ambulance corps, because although this organisation is still in an embryo state, it has already shown what may be expected of it. Small corps of Ambulance Volunteers had been formed at two or three places in Kent, and at Leicester, Leamington, and elsewhere. At Brighouse, in Yorkshire, the members of the local centre of the St. John Ambulance Association possess a carriage that will take four patients on stretchers, as well as attendants seated, and they have also five "Ashford" litters stationed at different points in the town. All this material is interchangeable, the stretchers fitting the horse-carriage and the litters, and I believe there is nothing of the kind more complete in England. But quite recently an attempt has been made in the metropolis to meet a want of serious importance. The manner of working is very simple, but I need not enter into details, as anyone present, before leaving this room, can have a copy of the printed regulations. These admit of the greatest elasticity, in order to embrace all classes and to meet special requirements. Allow me to cite one or two instances, which will prove better than any general statement how useful this corps has already been. A poor girl who was dangerously ill told her doctor that she would rather live a week in London with her mother than a month in the country separated

from her, and he gave his consent to her removal. She was brought from her cottage at Reigate to a room on a second floor in London, and she told her friends she was quite sorry when she had to be taken from the stretcher and placed in bed. The expense of this journey of twenty-two miles, including four railway tickets, was thirty shillings. By the same agency, within the last fortnight, a man with a fractured leg has been conveyed from London to Maidstone; a general officer has been taken eight miles out of town, and a poor woman has been removed from the train at Paddington Station to St. George's Hospital.

I have thus mentioned a few of many instances in this branch of work—the carriage and removal of the sick and injured—which has lately been undertaken by the St. John Ambulance Association. It may be admitted that at present as a business it is not a paying one, but if work be found for the corps it will soon be self-supporting. Every day we are gaining experience, and as we advance we make improvements in and even add luxuries to our material. Looking at the result of the last few months, I do not hesitate to recommend it to your warm and active interest.

My sole aim in this paper is to draw attention to a useful and pacific revolution that is gradually being accomplished for the benefit of suffering humanity. From one end of the kingdom to the other people are slowly acknowledging how little has hitherto been done outside our hospitals towards the alleviation of physical pain. The old days when a shutter or a hurdle was considered a sufficiently good means of locomotion for an injured person, or when specially constructed and luxurious invalid carriages were only within reach of the wealthy—these days have passed. The time is not distant when, as far as civil ambulance transport is concerned, the poor will be placed on an equality with the rich as regards comfort, if not luxury. Until quite recently, when a poor person was struck down by accident or disease there he had to remain. A change of air to the sea-side or elsewhere was out of the question on account of the expense, or rather owing to the absence

of proper means of conveyance at the disposal of friends who might be willing to help him. But a great change is gradually being accomplished. Mistakes will, perhaps, delay the realisation of our hopes, but all can do something towards it, and the labour will not be lost even though it may ultimately be proved to have been temporally in a wrong direction. I freely acknowledge my own mistakes in the production of ambulance material, and that I have learned much from the suggestions of those who have had opportunities of practically testing the results of my endeavours which were wanting to myself. Thus, and thus only, can we obtain anything like a solution of the questions which are now engaging so many minds.

I have already apologised for venturing to treat this subject from a personal as well as from a general point of view. But if I have committed an offence, I will still further expiate it by confessing my failures to anyone who is honestly desirous to take up the matter in a disinterested way; and I am sincerely grateful to those competent critics who have been lenient to my efforts even when they could not award them unqualified praise.

Ambulance work has a great future before it in England, more particularly as the country generally has not committed itself to any irretrievable steps involving considerable pecuniary sacrifice. Hitherto invalid transport, except at the cost of parishes, for short journeys to the workhouse or the hospital, has been limited to the rich. It is our duty to bring it within the reach of everyone, and to extend to all classes the benefit of change of air and scene when ill-health shall have made such change desirable; or when, as so often happens, a breadwinner is obliged to separate himself from his family because an invalid wife or child cannot be moved to a new home. Just in the same manner as it is mockery to recommend indigent patients when discharged from a hospital a diet of chicken, jelly, and port wine unless it be provided for them, so is it useless to tell them to obey the doctor's instructions and seek change of air, unless such a possibility is brought

within the means of the poorest. Consider what an expenditure of money is entailed, even on persons of comparatively easy circumstances, when, under medical advice, they desire to remove an invalid only five miles in a recumbent position. The tariff is in most cases prohibitive. We are all, then, interested—I will not say in a reform of our invalid transport system, because at present no real system of any extent exists—but in an organisation which shall so improve our present methods of removing sick and injured persons as to make it possible and easy for all, regardless of distance, whether journeys have to be performed by road, rail, or water.

One plan I would mention, which would greatly tend to these practical results, and that is, the formation in the metropolis of a permanent museum for the display of ambulance material under tne management of a small committee. to whom should belong the right of selection in the first instance, and change when improvements may render certain patterns obsolete. Such an institution is most urgently needed, and I am supported in this belief by letters in my possession, written by distinguished physicians and surgeons, both civil and military. I trust the day is not far distant when such a museum, exclusively limited to objects which come within this category, may be established, a distinct line being drawn between such objects as are only intended for civil use and those which are for war.

I am quite aware how imperfectly I have fulfilled my task on this occasion, but I know I am addressing many who have the power to carry the work I have so slightly indicated far beyond the limits that cramp and confine the energies of those who have to the best of their ability devoted many years to this particular subject. To those whose attention has never been directed to the matter, I would say: "Take the first opportunity to enable some suffering invalid, who is now pining for the fresh air and green fields, to enjoy a change from the hospital ward, or, may *be,* the gloomy walls of a chamber where a genial breeze

is seldom felt, and where the nerves of the patient are racked by never-ceasing street noises." An act of charity like this, and the charity need not necessarily mean the expenditure of money, will be well repaid by the result, and a recruit will be added to our ambulance band. And to those who have considered the subject, especially the doctors, let me appeal for work such as they can give us to do; and with their advice, criticism and encouragement, men and women will be found to labour zealously in the cause, and *the carriage and removal of the sick and injured* will soon become an organised institution, which will be a benefit to all whatever their position in life may be.

THE AMBULANCE ORGANISATION OF THE METROPOLIS DURING EPIDEMICS.

By V. B. Barrington-Kennett, M.A., LL.M.

Deputy Chairman of the St. John Ambulance Association.

After some years of ambulance work in foreign wars I was glad of an opportunity of utilising any little experience which I might have gained, by assisting in the organisation of the Metropolitan Ambulances for the transport of infected cases. Many of you may not know that the Metropolitan Asylums Board, under the able Chairmanship of Mr. E. Galsworthy, has, among its other duties, the responsibility of organising and carrying out the transport by road and river ambulances of large numbers of sufferers from the epidemics, which from time to time visit our great city, and commit such havoc among its crowded population.

As a member of the St. John Ambulance Association, I have gladly accepted an invitation to tell my colleagues at this Conference of our Association something of a new system and interesting branch of ambulance work. I wish, however, to preface my remarks by reminding them that I

am not here to-day in any way representing the Metropolitan Asylums Board or its Ambulance Committee ; I am only giving an account on my own responsibility, both as to facts and figures, of some of its ambulance arrangements.

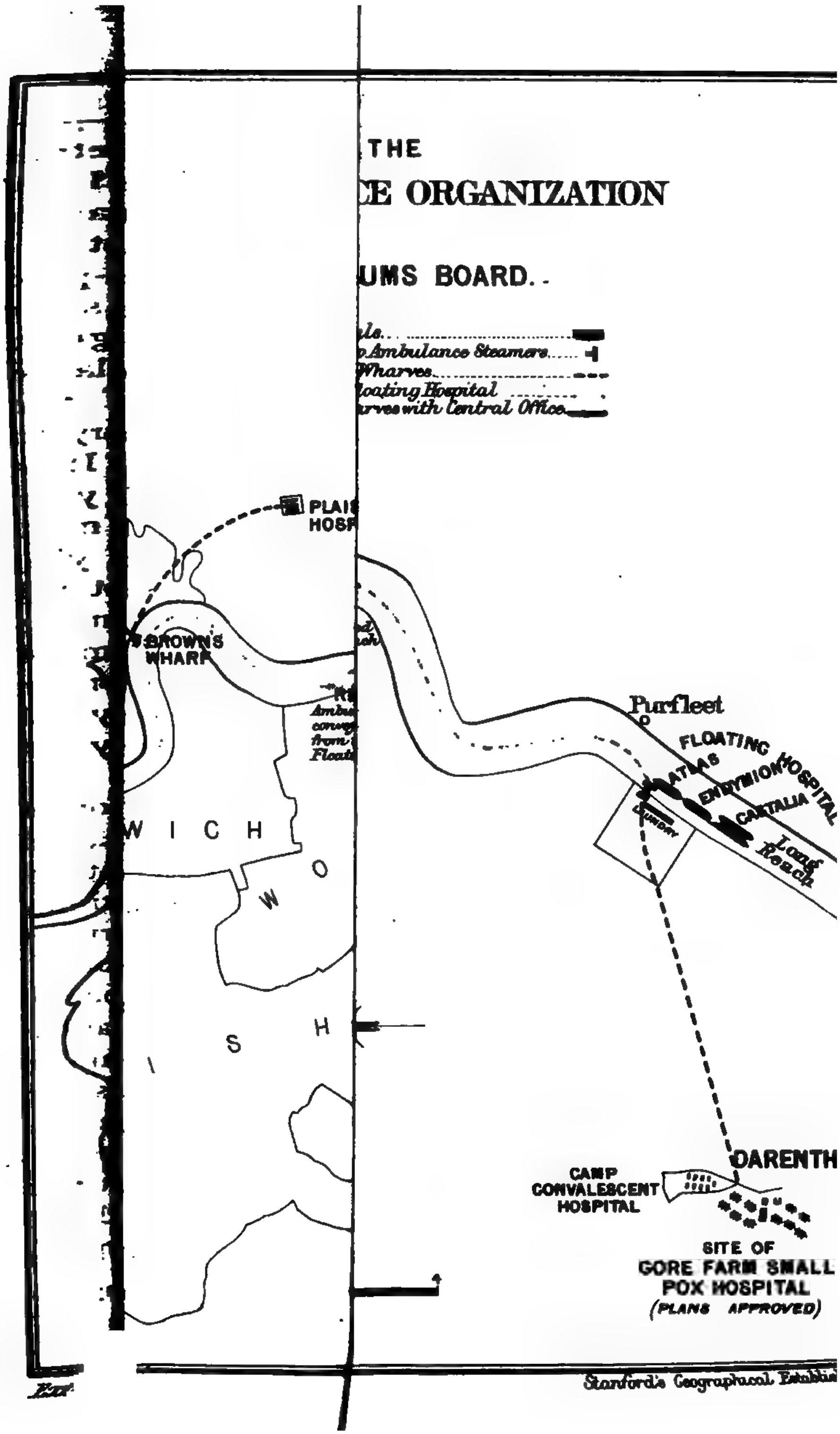
We are now, as you know, passing through a small-pox epidemic, and it need hardly be said that under such circumstances the removal of patients is a work of great magnitude and serious difficulty, on account of the large numbers to be dealt with, the crowded state of the thoroughfares, and the precautions which it is necessary to take in order to prevent infection during transport. It is to the public ambulance operations now going on in your midst in connection with this epidemic, and which must therefore be an object of some interest to most of you, that my remarks will be mainly confined. It cannot fail to produce a feeling of satisfaction and confidence among many of us to know that we have at our call in time of epidemics a powerful and highly efficient organisation for rapidly removing patients to the hospitals where they will be treated, and to the convalescent camps where they will regain health and strength.

I propose first to explain to you briefly the position of the various ambulance stations, hospitals, wharfs, &c., and the general routes followed in transferring the patients by road and river. For this purpose I have been kindly allowed to make use of the maps and some other articles contained in the Ambulance exhibit of this Exhibition.

Ambulance Stations.

Referring to the map* accompanying this paper, you will see that there are six small-pox hospitals situated in various districts of London, three of which are provided with ambulance stations, or depôts, in which are kept horses and waggons ready for immediate use. These ambulance stations, situated respectively in the east, west, and south-east of London, are in telephonic communication with the central office in Norfolk Street, Strand, to which during the day information as to fresh cases is sent. During the

* This map is reproduced from the map of the Metropolitan Asylums Board.


THE
CE ORGANIZATION
UMS BOARD.
Ambulance Steamers
Wharves
Floating Hospital
Wharves with Central Office
PLAIS
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FLOATING HOSPITAL
ATLAS
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CASTALIA
Long Reach
DARENTH
CAMP
CONVALESCENT
HOSPITAL
SITE OF
GORE FARM SMALL
POX HOSPITAL
(PLANS APPROVED)
Stanford's Geographical Establis

night and on Sundays application for an ambulance carriage is made at the ambulance station itself. Thus at very short notice indeed, in day or night, an ambulance carriage can be sent to any part of London.

The regulations at these ambulance stations are carefully drawn up and strictly adhered to. After taking a patient to any hospital, each ambulance carriage has to be disinfected *at that hospital* before it is allowed back into the station, and proper precautions are taken in the case of any of the ambulance staff who may be brought into contact with the patients.

Every ambulance station is fitted with coach-house and stables, disinfecting-rooms, laundry, kitchen, dormitories and lavatories, adapted to the wants of the resident staff. The staff consists of a superintendent, telephone clerk, drivers, helpers, nurses, and other employés; all quite distinct and separated from the hospital staff. The necessity for these precautions will be at once seen when it is remembered that the ambulance carriages and staff are constantly passing through public thoroughfares. This is also the reason why, as I have said, every ambulance carriage which leaves the station comes out pure and clean, *having been disinfected since carrying its previous case.*

All this is very different from what was going on only a few years ago. The authorities who then undertook the removal of infectious cases, used sometimes to be most careless as to the localities in which they kept their ambulance carriages when not in use. In one recorded case the vehicle used for infectious cases was kept in a shed in the workhouse grounds along with the parish funeral carriage, a van for the removal of the ordinary sick poor, the van for daily carrying bread to out-door poor, and a carriage used by the Guardians. Moreover, the vehicle was never disinfected after use! In another case the ambulance carriage was kept alongside an invalid-chair for ordinary sick people, while in a third case the driver employed to convey infected cases confessed to taking out people to evening parties and other entertainments without ever

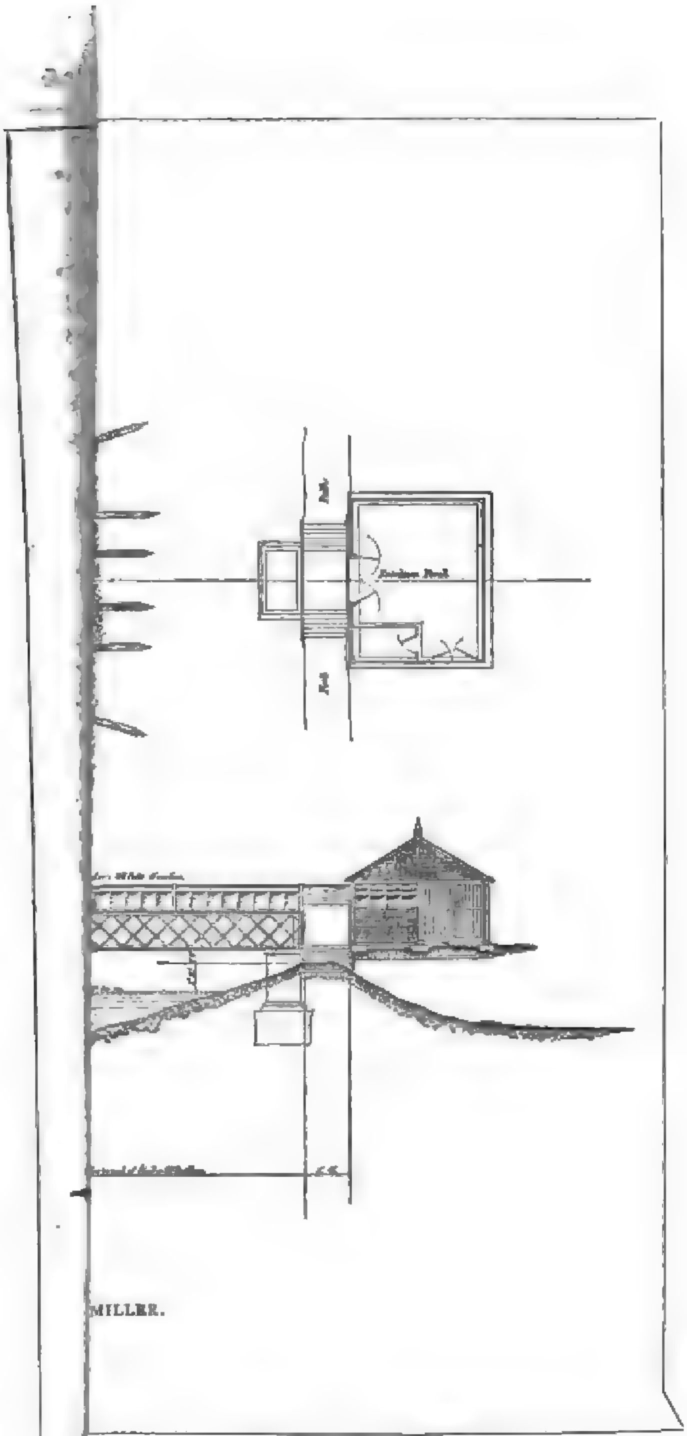
changing his clothes. I might quote other cases, but it is better to draw a veil over these scandals, and to console ourselves by thinking that in one matter at least this generation is wiser than its forefathers.

The evils of concentrating any considerable number of infected cases in London hospitals has been fully recognised, and in consequence, as many as possible of the patients are removed from them in detachments as the state of their health permits, and taken to the floating and camp hospitals, to the great benefit of themselves and of dwellers in the Metropolis generally. This floating hospital, which I shall describe more in detail later on, is situated on the Thames almost opposite Purfleet, nineteen miles below London Bridge, and the Convalescent Camp some our miles south of the Floating Hospital.

Properly constructed ambulance carriages convey patients from their homes to the hospitals or wharves, and in the latter case they are, subject to medical advice, taken at once on board the ambulance steamers, which call at regularly appointed times. If destined for the hospital ships they are taken there direct ; if for the camp hospital, they are disembarked at Long Reach Pier, whence ambulance waggons in attendance take them up to the camp. The time taken from the London hospitals or their homes to the wharves rarely exceeds an hour, while the river journey varies from 1 to 1½ hours. The journey from Wandsworth wharf, when in operation, will of course be longer.

Ambulance Carriages.

The ambulance carriages, thirty-eight in number, are distributed between the ambulance stations, and may be roughly divided into two classes—a large size, constructed or adapted to hold a maximum of five or six patients and nurse (but which will never, except on an emergency, carry more than four), used for transferring detachments of patients *from the hospitals* to the wharves ; and a small size, used for conveying one or two cases *from their homes* to the hospitals or wharves. A special feature in the form of ambulance carriage now adopted is that it is ventilated as much as possible from above, and that the



MILLER.

To face p. 336a

side windows do not open low down. The object of these precautions is to do away with the danger of spreading infection while the waggons are passing or delayed in crowded thoroughfares. The interiors are constructed of plain surfaces of polished wood easy to clean and disinfect. Trials have been made with zinc linings, and at the suggestion of Mr. Furley, some other improvements introduced in the last carriage built. One of his latest is a system by which a stretcher with a patient upon it can be raised from the floor of the carriage and placed on the top row by one man alone standing outside.

As an example of the work done by the ambulance waggons, I take the week ending July 5 last, and find that they were employed in the following number of removals :

Acute cases conveyed from their Homes to Hospitals and Wharves in London	241
Acute and Convalescent cases from Hospitals to Wharves in London	99
Convalescing cases from the Floating Hospital (Long Reach Pier) to the Camp	162
Recovered and discharged patients reconveyed from the Camp to Long Reach Pier	126
Do. do. from the Wharves to their homes in London . .	126
Do. do. from the London Hospitals to their homes . .	17
Total removals	771

If to these figures we add the fever cases, 61 in number, we arrive at a total of 832 removals in all during the week by the Road Ambulances. It must be remembered that a large number of these journeys are in connection with the Camp and not in London itself.

There are four ambulance steamers, of which two, the *Red Cross*, and one unfinished, are specially adapted for the conveyance of patients to the floating and camp hospitals ; while a third, the *Albert Victor*, though arranged to carry acute and other cases on an emergency, is mainly intended for the re-conveyance of recovered and disinfected cases from the floating and camp hospitals back to the wharves *en route* to their homes. The fourth steamer, the Ambulance Steamers.

Marguerite, is intended for the use of the Hospital Ships' Committee, and the nurses and other members of the staff.

The dimensions, and other particulars of these ambulance steamers, are as follows :—

	Length.	Breadth.		Depth.		Draught.		Accommodation of Patients.		Speed about.
								Lying Down.	Sitting.	
	ft.	ft.	in.	ft.	in.	ft.	in.			knots.
"Red Cross" .	105	16	6	6	6	4	6	16	150	10
New ship now building . .	132	16	6	7	6	3	0	36	200	10
"Albert Victor"	129	17½	0	7	0	[illegible]	0	20	150	12
"Marguerite" .	73	10	1	6	6	2	4	...	30	12

In the first three of these steamers patients can be carried on their stretchers from the waggons into the cabins without any difficulty, and can there be treated as if in hospital. Special care has been taken to provide for ample ventilation without draught. A doctor and nurses accompany the patients every journey, while food and medicines are kept on board to provide for all contingencies.

The following figures show the work done by the ambulance steamers during the week ending July 5, the same which I selected for the road ambulance returns :—

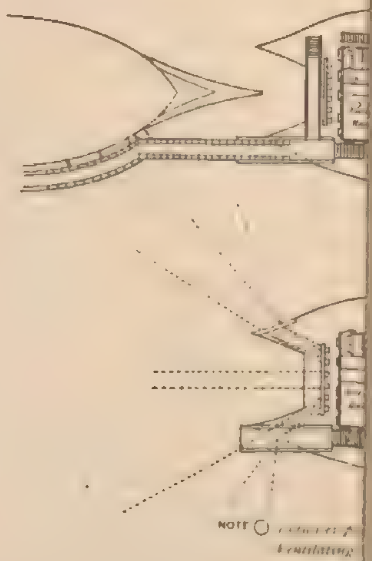
Acute recumbent cases conveyed from wharves . . .	129
Not acute and convalescent do. " " . . .	112
Recovered patients reconveyed to the wharves in London *en route* to their homes	126
Total	367

Ambulance Wharves.

The sites of the ambulance wharves have been selected as being in the most accessible positions with respect to the hospitals, and to the probable requirements of the various districts of London, special care being taken that they should, as far as possible, be approached by thoroughfares not likely to be blocked. When the whole scheme is carried out there will be four wharves, two on the Middlesex,

LONG REACH PIER.

ATLAS.



and two on the Surrey shore, viz:—One at Wandsworth (not yet constructed), Acorn Wharf at Rotherhithe, Brown's Wharf at Blackwall, and Long Reach Wharf, almost opposite Purfleet.

They will all be furnished with piers projecting to such a distance that the ambulance steamers can run alongside the landing stages at all states of the tide. These piers are to be covered in, so that patients can be safely conveyed along them in bad weather. A model of one of the wharves with its pier and landing stage is exhibited in the Ambulance Department of this Exhibition.

The following are some particulars as to the ambulance wharves, giving their approximate distances by road from the various hospitals, and by river from the Floating Hospital at Long Reach pier, where patients are disembarked for the camp. (See table on next page.)

It seems to be clearly established that the somewhat long journey by road and river to the Floating Hospital, which these figures show, is not prejudicial to the health of the patients. As a fact, they often express themselves pleased with the change of air and scene, and still more pleased when they are moved on to the Convalescent Camp.

Floating Hospital.

The Floating Hospital* consists of three ships, the *Atlas*, *Endymion*, and *Castalia*, moored in a line in the order named.

Atlas Hospital Ship.

Of these the *Atlas* is a fine three-decker, lent by the Admiralty, about 275 feet long and 40 feet broad. It contains three long wards, and though intended for 150, could take a maximum of 200 patients on an emergency. The ports of the ship have been enlarged and converted into windows, and in the middle of the ship a large aperture, or hatchway, 24 feet by 11 feet 6 inches, has been cut straight through the upper and lower decks. The effect of this, in conjunction with the series of windows replacing the ports, is to maintain an efficient system of ventilation, which is especially necessary owing to the lowness of the wards. However, I am still of opinion that a ship of this type is not the best possible foundation for a floating hospital.

* See illustration of Floating Hospital accompanying this paper.

Name of Wharf.	Shore.	Neighbouring Hospitals.	Distance by Road from these Hospitals to Wharf.	Distance by River from Wharf to Floating Hospital and Long Reach Pier.	Length of Pier.
			Miles.	Miles.	Feet.
Western Wharf, Wandsworth (not yet constructed).	Middlesex	North-Western Hospital, Hampstead	7	24	125
		Western do., Fulham	$1\frac{1}{4}$		
Acorn Wharf, Rotherhithe	Surrey	South-Western Hospital, Stockwell	$4\frac{3}{4}$	$14\frac{3}{4}$	300
		South-Eastern do., Deptford	2		
Brown's Wharf, Blackwall	Middlesex	South-Eastern Hospital, Homerton	4	$12\frac{1}{2}$	125
		Plaistow do. do.	$3\frac{1}{4}$		
Long Reach Wharf	Surrey	Floating Hospital	50 yards.	..	200
		Convalescent Camp, Darenth	4 miles.	..	..

NOTE.—See illustration of an Ambulance Wharf accompanying this paper.

The *Castalia** is only just beginning to be used. To myself she is of special interest, as I was responsible for the suggestion of the peculiar "echelon" arrangement of the detached huts on the upper deck, or "family of Noah's Arks" as they were called when the ship was lying in the docks; an arrangement which has been well carried out under the supervision of Mr. Adam Miller, while the long experience and critical eye of my friend, Surgeon-Major Bostock, C.B., has secured that no detail shall be wanting in the interior arrangements and fittings to make the *Castalia* a model hospital of her class. She is a twin-ship, which, as may be remembered, performed some unsuccessful voyages across the Channel, and was then abandoned as a passenger ship. She is built of iron, and is about 285 feet long, and over 60 feet broad. She has a long upper deck, and on it there have been constructed, diagonally or in *échelon*, five wooden sheds, of which the two end ones are 50 feet by 25 feet, and the remaining three 50 feet by 18 feet. The lower deck is divided into five wards, of which the two end ones are semicircular, with radius about 30 feet, and of the remaining three, two are 60 feet by 30 feet, and one 60 feet by 35 feet. She is designed to accommodate 150 patients, but could take 200 on an emergency. *Castalia* Hospital Ship.

The object of the *échelon* system is to have as much open space as possible in front of the windows in the long sides of the wards, and thus secure the maximum amount of cross-ventilation. The fact of some of these windows looking edgeways up and down the river gives a far more cheerful look out to the patients than if they looked direct into the wall or windows of the adjoining huts. The lower wards are ventilated artificially on the Boyle exhaust cowl system. A beautiful model of this ship, and the additions executed by Messrs. Green, the well-known ship-builders, is in the Ambulance Department of this Exhibition.

The *Endymion*, an old frigate lent by the Admiralty, 253 feet long, is used as an administration ship for her two *Endymion* Administration Ship.

* See illustration of *Castalia* accompanying this paper.

companions. Here the nurses and other *employés* live when off duty, and the office, cooking, and other administration work is carried on. At the present moment there are about 150 patients under treatment in the Floating Hospital, and a hospital staff of about 130 persons.

Steam-Laundry.

On the south bank of the river, just opposite the Floating Hospital, is situated the Steam-Laundry, where all the washing, for both patients and staff, is carried on. As the Thames water is hardly fit for washing purposes, the water, both for the Floating Hospital and Laundry, is conducted in pipes from the Kent Waterworks, a distance of four and a half miles.

Convalescent Camps.

Some four miles south of the Hospital Ships, on the slopes of the Darenth Hills, are pitched the two Convalescent Camp Hospitals,* at a distance of 360 yards from each other, one formed in March, and the other in June last. To show how rapidly this class of hospital can be erected and organised, I may mention that on May 30th last the order was given to form the second camp. and by June 21st—a period of only three weeks—there were 300 patients actually in the camp, with infirmaries, kitchen, laundry, boiler-house, and all that was necessary for their proper comfort and treatment. This result is mainly due to the energy of the Chairman of the Camp Committee, Sir E. Currie, and those employed in the work.

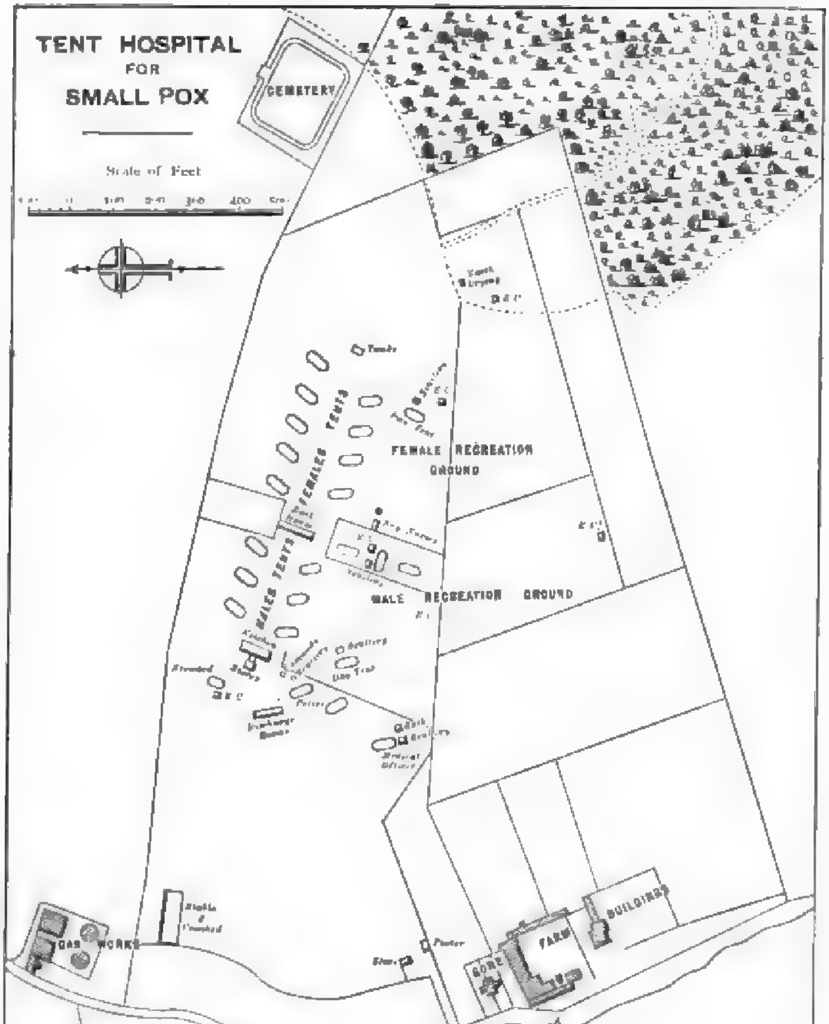
The sleeping-tents in these camps are pitched in double rows, with an interval of about 80 feet between the rows, and 50 feet from each other. They are occasionally arranged in *échelon*, to suit the undulations of the ground. The kitchens, boiler-house, bath-house and scullery are in wooden structures.

The following are the sizes of the principal tents :—

	ft.		ft.
Sleeping tents for 20 beds	50	by	25
Day tents	60	„	25
Infirmary tents for 16 beds	80	„	25

Good sanitary arrangements have been carried out at

* See plan of Camp Hospital accompanying this paper.


TENT HOSPITAL
FOR
SMALL POX
Scale of Feet
CEMETERY
FEMALES TENTS
MALES TENTS
FEMALE RECREATION
GROUND
MALE RECREATION GROUND
GAS WORKS
GORE
FARM
BUILDINGS
From Dartford

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these camps. Gas is used for lighting and cooking, and the tents are warmed when necessary by a system of hot-water pipes. At the present moment there are over 900 patients in the camps, but not long ago as many as 1200 were under treatment.

This new ambulance organisation, which has to-day been so imperfectly described to you, is undoubtedly an enormous advance on the old practice. It is not many years ago when poor people suffering from small-pox were known to be jolted for miles in cabs in which they could not even lie down. Again, to show how lax used to be the regulations and surveillance as to this important matter of transport, the following are some examples. They did not come under my personal notice, but I believe they are true stories. A certain costermonger, attacked by small-pox, arrived at one of the hospitals in a cab which had been converted into a makeshift ambulance. He was accompanied by a brother costermonger inside, and two others on the box. An interesting example of professional attachment! Cases used not to be of unfrequent occurrence in which friends gave a farewell shake of the hand at the hospital door to some less fortunate companion afflicted with small-pox or fever, wishing him a speedy recovery. Again, it has been related how a certain ambulance cab once solemnly drove up to a hospital, and the driver produced a certificate of an acute scarlet fever patient, of which he was supposed to be the bearer. To the astonishment, however, of the learned doctor, out popped from the cab a merry little man, rubbing his hands, and having all the appearance of enjoying robust health and a good joke into the bargain. On the driver being asked to explain, he said that he duly drove up to the house of the fever case, and after remaining some time heard the cab-door slam. Thinking that this was a sure sign that the patient for whom he was sent was all right inside, he drove on. His story was quite true. The merry little man had observed the fever carriage stop, and as he thought he would enjoy a drive, he jumped in and slammed the door.

His little joke was perfectly successful, and he had an hour's pleasant drive at the expense of the ratepayers. In another case, a happy party arrived at a certain hospital, the driver intoxicated and the patient also. In attempting to get down from the box, the driver fell and broke his leg! Such irregularities, to use a mild term, would under the present arrangements be impossible.

In conclusion, the work of the new ambulance system now in operation may be briefly summarised as follows:—Infected persons are being removed from the Metropolitan area, and recovered patients reconveyed home, at the average rate of nearly 300 a week, with the result that nine-tenths of the small-pox patients, instead of filling the London hospitals, are being treated in the country, twenty miles from the Metropolis. At the same time, it seems certain that the convalescence of patients is being accelerated under the favourable conditions in which they are placed in the Convalescent Camps on the Darenth hills.

We are, however, still passing through an epidemic. We are not yet out of the wood, and the new system has yet to bear the test of time. It looks hopeful indeed that the number of fresh cases of small-pox is now gradually, but decidedly, diminishing; if this result can be in part attributed to the rapid and systematic removal of so many hundreds of infected persons from our crowded Metropolis, it will amply repay the time, trouble, and expense, which has been so freely devoted to the organisation of the ambulances of the Metropolitan Asylums Board.

DISCUSSION.

Baron Dr. MUNDY complimented both the gentlemen who had read the papers, each of whom had already proved their capacities on the field of battle in time of war, and who now devoted their energies to the alleviation of suffering in times of peace. He also

congratulated England on possessing such organisations which would no doubt soon be developed on a large scale, not only in this country but abroad. In a short time he believed there would not be much more said about ambulance work, but much more would be done. Looking only at the military side of this particular work, the progress was very astonishing, and coming back to accident and illness in times of peace, there was no doubt sufferers had been greatly injured by the unskilful and irrational modes of transport which had been adopted. If the mind of every one were directed to the necessity of further progress in this direction, the work would go on until it became so general that there would be no necessity for speaking more about it. With reference especially to the question of treating those affected with infectious diseases, there had hitherto been great negligence and want of care with regard to their transport, even in countries where medical men and those properly instructed in the matter thoroughly acknowledged the necessity for due precautions being taken. The epidemic which was now raging in the South of France was a striking instance of the necessity for providing for such dangers before the necessity actually arose, and the recent lamentable railway accident should also show the necessity of all kinds of appliances being kept in readiness on all the lines of railway, and for the persons engaged in those railways being properly instructed as to the care of the wounded.

Sir JOSEPH FAYRER, K.C.S.I., said he had listened with the greatest pleasure to both these papers, and thought it must afford a great consolation to every one's mind to know that these provisions were made in the event of the sickness which certainly might be regarded as imminent. We were in the middle of an epidemic of small-pox, and were threatened, though perhaps not seriously at present, with a possible epidemic of another sort, and it behoved everyone to make such provision as he could for the proper care and management of the sick. It had often been to him one of the most serious considerations, if anyone in his own house

were to be suddenly seized with infectious disease by what means could he get that person conveyed to a hospital, because he knew that there he could have much better treatment and care than he could possibly have in the best house in London. He did not know until that day that such excellent means had been devised, and though they were at present only inchoate, there was every prospect, he hoped, of the organisation becoming much more greatly developed.

Dr. BILLINGS (United States Army) said listening to these papers brought to his mind scenes which occurred long ago when he first entered the army, when practically they had no ambulance organisation whatever at the beginning of the war, and he had been running over in his mind the various steps taken until they had what might be called a very satisfactory system. No one who had not seen the terrible sufferings which resulted when the provisions were defective, or when there were none at all, when all was confusion, could fully appreciate the importance of being wise in time in providing organisation and trained men. One of his first experiences in this matter was the second battle of Bull's Run, when they impressed all the hackney coaches, and in fact every other vehicle in Washington. He recollected in one case a gentleman and his bride had to get down in front of the hotel as they were starting on their wedding trip, their carriage being taken, with everything else that could be got hold of and utilised as best they could. By the end of the war, however, they had an ambulance corps of men properly drilled; they had got rid of the clumsy waggons and carts, and had light, easy running waggons drawn by two horses, and were able to deal with 5000 to 8000 or 10,000 wounded, and bring them to hospital, and of course they had there to traverse a country very different to anything in Europe. One of the great improvements now going on in America with regard to the care of the sick and wounded was the provision made by the railroad companies themselves, some of which had cars carefully fitted up with all apparatus ready

to be moved to any point where there was an accident, besides which they provided small hospital knapsacks, or companions as they were called, to be carried with every train, so that there should always be the means of dressing a simple injury. Then, again, in some of the large cities, notably Boston and New York, and to a less extent in Philadelphia, there was a very complete municipal ambulance system, by which any one could obtain an ambulance in a few moments; it was worked almost on the same system as the fire brigade, and had done excellent work. The special reason why it was very desirable that there should be some preliminary organisation for military purposes was, to avoid the confusion which sometimes existed when hastily formed voluntary associations, not always perhaps doing quite the wisest thing, though acting with the best intentions, came into conflict with the Army Medical Department in its organisation. That occurred to a slight extent at the beginning of the war in America. He did not wish to be understood for one moment to depreciate the enormous value of these voluntary organisations, but only to show the necessity of their being provided and organised beforehand, so that there should be a perfect understanding between them and the Army Medical Department, which they came to assist. In the first portion of the war a very large amount of material and money was wasted simply for want of organisation and training.

Dr. CRAWFORD (Director-General of the Army Medical Department) said he came to learn rather than to speak, and had not thought out any particular point on which to address the meeting; but this subject was so entirely new that one could hardly make a mistake in addressing himself to any particular portion of it. He should, of course, have preferred addressing the meeting on the military aspect of the work, but probably that would be less interesting to the meeting than the aspect which the subject presented from the civil point of view. In reality, the great question to be solved was when you had a sick, wounded, or injured man or woman requiring to be removed from the place where

they were injured to a place where they could have proper medical aid, how was that to be most easily, safely, and expeditiously done. Heretofore it had been an altogether haphazard matter; when a man fell from a scaffold, as a rule, he was pushed into a cab regardless of the nature of his injuries, and, in nine cases out of ten, he might possibly be injured much more on the journey to the hospital than he had been by the fall from the scaffold. These things were discreditable to medical men, because it was the duty of the profession to teach the public what was required, and to leave the onus on the shoulders of the public how that requirement should be met; but they were also discreditable to the nation at large, because many men, like Mr. Furley and other gentlemen, had been preaching for years on this matter, and yet people were not sufficiently alive to the importance of it. With regard to shipwrecks the nation was thoroughly alive, and on almost every headland there was a lifeboat institution, well organised and trained, and well supported; but taking the cases of injuries by railways, in coal-mines, injuries by flood and field, on scaffoldings and elsewhere, among the whole population, what provision had yet been made? Practically, with the exception of this admirable provision in London to meet the requirements of contagious disease, they were almost without any. As was well said the other day by the Marquis of Lorne to a member of a London Ambulance Association, we must not be satisfied with the work of that Association until every village in England should have its stretcher party and ambulance school. One other aspect of the question he might just refer to; why were the great hospitals all over the country so indifferently supported considering the great need for support that all had at the present moment, and why were they less popular than they ought to be, considering the first-class skill brought to bear on the requirements of the sick in the medical as well as in the nursing departments? One of the reasons was because, he thought, every person knew how difficult it was to get a sick or wounded person from the house to the hospital,

and consequently, looking on this as an insuperable difficulty, they took less interest in these institutions. To meet that requirement was the object amongst others of this great movement, and he hoped a few years hence would see every hospital provided with the means within itself of sending for patients, and every village providing within itself the means of sending to the hospital the accidents and injuries which might require treatment.

The CHAIRMAN said the Director-General had touched a very important question, that of the difficulty of transporting patients to hospitals. There was a gentleman present who could speak as to the work done in the Northern Hospital of Liverpool, and he would therefore ask him to give his experience.

Mr. R. HARRISON (Liverpool), said he would in a very few words contrast the position of things before this movement arose with what it was at present. Speaking of Liverpool, with which he had been associated for many years—but probably the same remark would apply to other large cities—he did not think anything could possibly be worse than the way in which people were brought from the scene of an accident to the hospital. It was very frequently remarked by the surgeons who examined these cases, and condemned a limb to amputation, that this necessity did not arise from the accident, but from the treatment to which the patient had been submitted in the process of removal. That remark had been re-echoed by Dr. Crawford, and was generally known throughout the large hospitals, but it was most important that the public at large should also understand it. In 1881 he had the pleasure of paying his second visit to the United States, and during that visit he took a very deep interest in the ambulance question. He remembered one remark made by a surgeon in New York, who was deeply interested in the subject, who showed him everything connected with the transport of sufferers, expressing his great surprise at hearing that in England there was nothing of the kind, and he said that in the United States they could not afford to lose a single

life. On his return to Liverpool he laid this subject before the medical authorities there, when he was glad to say it was warmly taken up, and now, throughout Liverpool, they had ambulance waggons and litters, which he could assure them were doing a most admirable work. Patients were now brought from the docks and steam-ships, and from the suburbs, who had been subjected to severe injuries, in a far better condition than formerly, and in consequence far less amputation took place than before the ambulance movement, simply because the hospital treatment began, so to speak, at the time of the accident, and the patients were not brought doubled-up in cabs, or conveyed on the backs of their comrades, causing fractured bones to take a course which, before such an audience, he should not like to describe. They had been satisfied with the result of this work beyond measure in Liverpool, and he was quite sure it had been the means of giving, not only great comfort to these people, but had saved not only many limbs, but many lives.

Dr. FARQUHARSON, M.P., said, although he had the honour to be an Associate of the Order of St. John, his knowledge of the subject was not so precise or accurate as it ought to be, though, thanks to the two admirable papers which had been read, he had learnt a great deal since coming into the room; the first paper showed how useful it was for persons to acquire this elementary surgical knowledge. Probably there were not many present who had not attended an ambulance course of lectures, and he dared to say that many of them knew the exact course of the femoral artery, and were prepared to reduce a dislocation at a moment's notice, but the objection had been made that persons having this theoretical knowledge, when it came to the point, lost their heads and presence of mind, and became perfectly helpless at the sight of blood. Now, it was quite evident from what had been said, that this was not the case, but that those who had attended these lectures were able to go forth and use their theoretical knowledge with efficiency and skill. A real benefit had therefore been

conferred on suffering humanity by the skill with which persons were treated before their removal to the hospital. The second paper was, perhaps of even greater importance, as it showed how infectious patients were being moved to hospitals without the fear of infecting others. In old days, removal to an hospital simply meant an ingenious and elaborate means of spreading infection to other people. Some instances had already been given, and perhaps many would recall one which was mentioned in the 'Times' some time ago, about a person passing a small-pox hospital, who saw a cab drive up and deposit a very bad case of confluent small-pox, and when it had driven about fifty yards off actually take up another fare, and drive off with it Under these excellent arrangements nothing of this kind would be possible in the future.

Surgeon-Major HUTTON then read the following short paper :—

IN the limited time allowed in these meetings for discussion, I can only select one subject for comment, among many relating to the removal of the sick and injured. This one, however, is very important, as it has close connection with the national health and the national wealth. I would refer you to the numerous accidents that are continually occurring among our large mining population, our colliers and ironworkers. By way of example, I would first refer to an individual case. A man, a skilled artizan, has his leg broken in one of our large ironworks in the Midland counties. Let me read to you an account of the accident, as given to me in a letter from the doctor in attendance. "The man was hurt in the beginning of February—his injury was a simple fracture of the leg, and carrying him home the fracture was complicated by a serious displacement of the foot, which has acted so seriously that a limb which would have been well in three months, will take at least seven months before it is quite sound." You see there the unfortunate result of

want of system, care and skill in the removal of an injured man :—fully 16 weeks more, in this case, of enforced idleness, for lack of timely first aid and careful removal in the manner recommended by Mr. Furley and the St. John Ambulance Association. Now, the man was in receipt of 30*s.* a week, and, of course, during the whole period of his sickness, this has been lost, but that is not all, he has been receiving from the Employers' Liability Assurance 10*s.* a week, and another 5*s.* from the sick club, making a total loss of £2 5*s.* a week. The question arises, can we sum up this loss as dead loss, for, of course, the sick bequests replace the wages as the family's expenditure, but then the man's productive labour is lost to the amount of his own wages, and his employer's profits also; unless having taken on another man who was out of work, then we must cancel the 30*s.*, as being dead loss to the sufferer only, and not to the productive labour of the community. If so, you must subtract the money he receives from his wages, and say he loses 15*s.* a week, and the clubs 15*s.* a week more. It seems to me an important calculation, and I should like, when opportunity affords me, to take the opinion of some expert on questions of social economy on this case. It must be evident, however, to everyone here, that the loss to this man and his family is very great. The money he receives per week for the support of himself and family is reduced from 30*s.* to 15*s.* a week, and that means less food, less clothing, less of the actual necessaries of life, and therefore less health for his family. Now, this is one of many thousands of cases that take place every year among our great mining and industrial classes. Let me instance a private engineering and manufacturing firm, employing, perhaps, the highest skilled labour in the country. I find that in one year (1883) their accident compensation fund had paid £1,306 8*s.* 1*d.* for injuries received by the workmen, 214 claims had been admitted, and the sums awarded varied from 2*s.* 3*d.* to £200. This firm has, during the last winter, introduced proper ambulance *matériel*, and a large number of their men have been in-

structed in using it, and in a letter I have recently received from the secretary of the accident fund, he states, "when preparing the report of the ambulance classes, I called the attention of the committee to the remarkable diminution in the number of cases coming forward for compensation."

Carry this inquiry still further, to a district, the great iron-mining district of Cleveland and North Yorkshire. From returns that have been furnished me by the Secretary of the Miners' Association, for the year ending December 31st, 1883, the total number of accidents reported were 847 non-fatal, and 29 fatal. This report states, "if we make a very moderate calculation in relation to the accidents which have not been reported, we arrive at the startling fact that one person has been injured or killed during 1883 for every eight employed in and about the Cleveland mines." Some of the non-fatal accidents have been of a very serious character, laying off work the sufferers for weeks and months; and I am sure a perusal of these returns convey with terrible distinctness an idea of the dangerous nature of the miner's work. I cannot give a correct account of the time lost in all these cases, but, in another report of a small cottage hospital in this district,—the "Guisborough Miners' Accident Hospital"—75 injured men have been treated during the same year (1883). Many of these were serious fractures, and the combined time these cases were in hospital amounted to 750 days, or upwards of two years' employment. That did not mean all the loss, for many of these poor fellows, after they left the hospital, had not regained sufficient strength to resume work for some time, so serious had been the nature of their injuries.

If we extend our inquiries to the coal and iron-mining districts generally throughout the country, you will find that there are some 560,000 men and boys employed, and that one relief society alone in one year assisted 14,929 injured cases, and last year (1883), out of a total membership of 224,000 belonging to the various societies in our mining centres, no less than 44,579 cases of injuries were relieved. Lord Crawford and Balcarras, a high authority on

these matters, stated at an ambulance meeting at Wigan some time ago, there could be no doubt that as many as 100,000 accidents, large and small, occurred throughout the mining districts of this country in one year. Surely, then, with facts such as these before us, so much pain and suffering to alleviate, there is abundance of good work to be done by proper means of carriage for the injured, as brought to our notice by Mr. Furley. It must be obvious to every one, from the facts and figures I have quoted, that this subject is one largely affecting the national health and the national wealth, and especially the health and well being of a class of men whose toil and whose labour contribute so much to the comfort and wealth of the nation. I believe it would afford much pleasure to His Royal Highness the Prince of Wales to know that this Exhibition had been the means of assisting in promoting work calculated to relieve pain and suffering among our mining population, by assisting in the introduction of well-regulated means for the carriage of the injured everywhere among our collieries and ironworks. I would ask, then, everyone here to examine for themselves the ambulance exhibits, and to exert their influence to foster and extend this good work. I would particularly urge upon the owners of royalties in mines that they should largely contribute, and unite with those who work the mines, to provide proper ambulance material for the mining districts. I hope the day is not far distant when this work of the St. John Ambulance Association, the safe carriage of the sick and injured—will take the same place in the hearts of the people of this country as that other noble work, which has done so much during the past sixty years to save life and relieve suffering on our stormy coasts—the work of the Royal National Lifeboat Institution. I ask you all to assist Mr. Furley and the St. John Ambulance Association in making more widely known this humane and christian work, for in reality it is, if only the public were made aware of it, *A National Life Brigade upon the Land.*

The CHAIRMAN said he might venture to hope that all who had heard the paper and address had been as much gratified as he had himself, for he must reckon himself as one of the audience, his office of President carrying with it no pretence whatever of being a leader in relation to this subject, or even to be well acquainted with it. He had to confess, like possibly some who had listened to the addresses, that he had no familiarity with ambulance work. His occupation in his profession had been of a totally different kind, and he had been so entirely engaged in it, that he had had no opportunity or time whatever to study the very useful facts which had now been placed before them. There was, in fact, only one direction in which he had studied them, namely, that as surgeon to a large hospital he had constantly seen the need there was for a better transfer of patients, whether sick or wounded, into the hospital wards; and he could, of course, from his own experience, tell numbers of instances similar to those which had been mentioned. In apology for himself and others who had to do with hospitals, he must remark that, when they looked at the difficulties which existed, they could not but observe that as the difficulties existed everywhere so must the remedies be everywhere. They might have arranged a system of ambulance close by, but the patients in large hospitals were brought from the narrowest streets and the most distant villages, and from every part of the country, and it needed the enterprise and co-operation which was shown in a society such as this, to be able to take in hand a work of which the design would be, as they had developed it, to spread the system of ambulances far and wide to every village in the kingdom, and to bring the knowledge of its utility and its application within the range of the whole community. The work was not one-half, nor yet one-tenth, accomplished when an ambulance was established even in that great city, whilst they did not exist in places 10, 15, 100, or 200 miles off. The Association, however, had shown its intention to work this affair

completely and successfully, and he would recommend it to all present as an admirable instance of that which they might justly boast of in this and other civilised countries, namely, that if you only showed to certain persons the way in which they might be useful, and how they might exercise themselves, not subject to any governmental or central control, in doing good, it would surely be done. No example of this truth could be better than the one now illustrated. He must not be held, however, to imply that work of this kind could not be done except by purely voluntary agency. The work of the army was, with the whole discipline of the army, perfect and complete in itself. The work of the Metropolitan Asylums Board, as had been illustrated to-day, was also admirably complete under the central governing body; yet, as he knew pretty well, having been a member of the Commission, the work of which, with regard to infectious fevers, had one of its issues in the facts mentioned to-day, that work was done mainly by those who gave themselves to it as a voluntary task and duty—not by defined and paid officers of any kind, but by men like Mr. Barrington-Kennett, Mr. Galsworthy, Sir Edmund Currie, and Deputy-Surgeon-General Bostock, who, with the purest philanthropy and the most devoted sense of duty, had worked at this matter, so that the work both of the Society and that which was done under the Metropolitan Asylums Board might be thoroughly commended. He might add, however, that this method of the transfer of the sick to infectious hospitals was but a very small fragment of the great work which was being done. The management of the fever and small-pox hospitals in London might, to the best of his belief, be taken as a model by every country in the world. They had heard how valuable this system had been in Liverpool, and he must say he never passed through Hyde Park without admiration for the ambulance arrangements made there, chiefly at the instance of Mrs. Priestley, the result of which had been a very great diminution in the seriousness of accidents to which that part of London was most exposed.

All the officers of the staff of St. George's Hospital could tell, as Mr. Harrison had already told, how the injuries they had to deal with became less in proportion as the ambulance system was developed in the Park. He would venture, then, to urge on all present, and ask them to urge on those who were not present, the duty of helping in every way they could in the extension of this important work of first help for the sick and wounded. He might as well say that in doing it, although he was rather against going down to a lower motive, there might be an excellent selfish one as well. He, who in these matters had learnt to help others, had also learnt how to insure the best help for himself. There was a story which he believed was authentic, concerning one of the most brilliant of his predecessors at St. Bartholomew's Hospital, Perceval Potts, the teacher of John Hunter. He was thrown from his horse on London bridge a century or more ago and fractured his leg. The people were as benevolent then as they are now, or nearly so, and rushed to help him, but with his whip he cut this way and that, and drove them off, and they thought he was mad. He cried out, "Send me a shutter," that being the best litter for him at that time, and then he quietly shifted himself on his back to the shutter, and had himself carried home with his simple fracture not rendered compound. That would illustrate the benefit every one might secure for himself if he would learn how to help his neighbours in such matters. Finally, he would balance the instances of selfishness rewarded, by reminding his audience how completely the ambulance work might be the exercise of charity. Few things, indeed, were there in which charity could better exercise itself than in this. There was ambulance work or first help in that incident which led to the giving of a command the most general and most unconditional—where a man finding another wounded by the roadside poured in oil and wine, and set him on his own beast, and took him to the inn. That was an admirable example of what might be ambulance work, and the command was, "Go thou and do likewise."

Sir E. LECHMERE, M.P., then proposed a vote of thanks to the chairman. There was no doubt the interesting papers they had heard, and the discussion which had succeeded would do much good, as it would make the work of the association known; but he believed that nothing would do so much good to promote interest in ambulance work, and to convince the medical profession throughout England and other countries of the reality of this work, as the presidency and cordial support which Sir James Paget had given to it. In the first initiation of this work the association sought the advice and sympathy of the medical profession, who had most freely and liberally given it, and from that moment they had tried and determined to deserve their confidence. To some extent they had done so, but every one would allow that the greatest proof that they had at last succeeded in obtaining the acme of their hopes, was the fact of having secured as the president on this occasion one so distinguished as Sir James Paget. He hoped that meeting would produce many good results, and amongst others that it might lead to the establishment of such a permanent museum in connection with ambulance work has had been suggested in Mr. Furley's paper.

Sir EDWARD PERROTT seconded the vote of thanks, which was carried unanimously, and the proceedings terminated.

WATER SUPPLY AND DISTRIBUTION.

CONFERENCES BY THE SOCIETY OF ARTS ON THURSDAY and FRIDAY, JULY 24th and 25th.

CONTENTS.

WATER SUPPLY AND DISTRIBUTION.

CONFERENCES ON THURSDAY AND FRIDAY, JULY 24 AND 25, 1884.

Sir FREDERICK ABEL, C.B., D.C.L., F.R.S., in the chair.

THE CHAIRMAN, in commencing the proceedings, said the active interest displayed by his Royal Highness, the President of the Society of Arts, on this subject, had led the Council to hope that it might have been in his power to open the proceedings; indeed, at one time, there was no doubt that this Conference would have been the opening one of the series arranged by the Executive Council of the Health Exhibition, and that his Royal Highness would have presided, at any rate, over a portion of the proceedings, when that unexpected calamity occurred which had so deeply afflicted the Royal Family and the nation. The fact that even quite recently the Prince had fixed the present date for this Conference was an indication that, had it been possible, he would have marked his sense of its importance by attending at the opening. In 1878, his Royal Highness addressed a letter to the Council of the Society of Arts, calling attention to the importance of the subject of water supply; pointing out that whereas various large towns were at that time incurring heavy expenditure to improve their water supply, smaller towns, and particularly villages, were left to shift for themselves; and suggesting that it might be desirable to discuss fully the question how

far it might be possible to apply the great natural sources of water supply according to some national comprehensive scheme. The Council of the Society, acting on that suggestion, issued inquiries and invitations for papers, and received more than twenty papers in response, some written by men of eminence who had devoted a great deal of attention to this subject. Those papers, and the topics arising out of them, were very carefully discussed, and the general conclusion arrived at was that local conditions and circumstances presented such very considerable variations that it appeared impossible to devise any comprehensive national scheme for the supply of water to communities. But a resolution was passed that it was desirable to memorialise the Government to appoint a small permanent Commission to collect facts connected with the water supply throughout the kingdom, in order to utilise the natural resources, as indicated by his Royal Highness, according to some general system for the benefit of the country as a whole. That suggestion was not acted upon, but, nevertheless, the discussion which took place in 1878 had been fruitful of beneficial results, and it was quite certain that the subject of improved water supply had made an important advance since that time. The influence of polluted water in promoting the spread of epidemics had become more thoroughly understood and recognised, and the mischievous effects of using water derived from surface wells, and from the careless storage of water in houses, arising out of intermittent supply and other circumstances, had received much public attention; but there could be no doubt that many points bearing upon the supply of wholesome water still required further elucidation. Many interesting discussions connected with one branch or another of this subject had taken place since 1878, and probably none were more interesting than those connected with the questions as to what constituted a good water for drinking and domestic purposes, and how a sufficient quantity might be ensured. It was scarcely necessary to remind the audience that amongst the most intelligent men who had given attention

to this subject there had existed, and still remained, diversities of opinion on some important points more especially connected with the question of how the purity of water was affected, and how it was re-established if the water were once polluted. Thus some authorities had maintained that no river which had been in any way polluted could ever be fit for use afterwards, or, at any rate, that the time when it might become fit for use as potable water was very remote; but that, on the other hand, it was only necessary to sink wells deep enough in order to obtain water absolutely free from injurious organic contamination, so that water could be furnished in any degree of abundance by means of artesian wells. On the other hand, there were authorities, not less well recognised as possessing special knowledge and experience, who had maintained that it was quite erroneous to suppose that river water, when it became polluted by sewage, was thereby rendered permanently unfit for potable purposes; that a river had only to flow a comparatively short distance for its self-purification to take place, a purification which, although it might vary in degree according to circumstances, must ultimately he carried out to a sufficiently perfect extent to render the water absolutely wholesome. Probably the truth lay between the extremes; in fact, it was already recognised that it did so, and there were indications that amongst the most extreme exponents of either view there was a tendency to an assimilation of opinions. These subjects had been lately so warmly fought out on many battle-fields that the weak points on each side had become more and more apparent to advocates and adversaries alike; and, therefore, there was a hope that something like that unity of view might, before long, be arrived at, without which any real progress cold hardly be looked for. There was probably no subject which could be selected for discussion which involved so many considerations of primary importance as that of water supply. On the one hand, there were geological, medical, chemical, and engineering considerations; and, on the other hand, there were financial, legal, municipal, and it might be even

political considerations. As the Society met on this occasion, in conference in connection with the Health Exhibition, he thought they were primarily concerned with the first-named set of considerations, and their hands would be quite full enough if they limited themselves to these, avoiding, as much as possible, any discussion on the extremely debatable ground of financial or legal questions. They would now at once enter upon the consideration of the first branch of the subject, viz., the Sources of Supply.

I.—SOURCES OF SUPPLY.

ON THE AREA OF CHALK AS A SOURCE OF WATER SUPPLY.

By W. Whitaker, B.A., F.G.S.

Of the Geological Survey of England.

It is only of late years that we have had the means of measuring the area of the great water-bearing formation of the south-east of England that can be reckoned on as a gathering-ground with certainty; and now we can do this for only a limited part of the chalk tract. As it will be a long time before we can do it for the whole, even so far as the London basin is concerned, I have not hesitated to bring forward the subject in its present imperfect state.

On ordinary geological maps, including the greater number of those as yet issued by the Geological Survey, the chalk, beyond the parts where it is covered by the eocene tertiary beds, is shown as bare, except for outlying patches of those tertiary beds (mostly on the high grounds), and for strips of alluvium (or marshland) along the bottoms of the chief valleys. For some years past, however, the Geological Survey has carefully mapped those varying deposits of clay, loam, and gravel, and sand, usually

grouped under the name of drift, which cover, in a more or less irregular way, the various divisions of the tertiary beds and the chalk, and which have a marked effect on the nature of the country where they occur to any great extent.

It follows that it is only in those parts of the chalk tract where the Geological Survey has mapped the different divisions of the drift, that we are able to tell, with an approach to accuracy, over how much of the surface the rain has a more or less free access to the chalk, and can therefore sink into it, and add to the supply to be got from it at lower levels.

In the course of a somewhat prolonged and detailed examination of this question, I have constructed a set of maps for the purpose of showing over what areas the chalk is bare, over what areas it is covered by beds of a permeable character (allowing of the sinking of water through them to the chalk), and over what areas it is cut off from the reception of water through being covered by impermeable beds. This may seem, on first thoughts, a simple matter; but, on trial, it is hardly found so, and instead of confining myself to three colours, one for each of the three areas above noticed, I was obliged to use a fourth, for various beds of a doubtful character, either from their being of a mixed composition, or of a changeable one, at this place permeable, at that the reverse.

With these four colours I was at first content; but the fact that in some areas where the chalk is protected by impermeable beds, the water flows over the surface until it reaches the chalk, and then sinks into that rock, has led me to show those areas by a lighter tint, as they contribute somewhat to the water in the chalk, and should, therefore, be distinguished from tracts that do not.

Beyond these five divisions the maps now exhibited do not go; but it may, perhaps, be needful to make a sixth, and to mark off from the rest of the bare chalk those parts where the base of the formation, the chalk marl, is so clayey as to be out of the question of water supply. This tract, however, would be a very narrow band along the outer edge of the chalk.

Possibly too, in extending the work (as I hope to), it may be well to mark areas where beds below the chalk may contribute to its water supply, or where rather the water system of the chalk may join that of some underlying bed. This, of course, would take place where any mass of permeable upper greensand is not divided by clayey chalk marl from the chalk above, in which case there will be but one water system. There is one remarkable part of the chalk tract surrounding the London tertiary basin, where, from the absence not only of the clayey chalk marl and the underlying (but much more local) upper greensand, but also from the thinning out of the usually persistent gault, a markedly impervious bed of clay, it results that the hard ferruginous sand (or carstone) of the lower greensand at once underlies the hard massive chalk. In the north-western corner of Norfolk, where this takes place, from Hunstanton southwards to near Sandringham, the water systems of the chalk and of the upper part of the lower greensand join ; though the lower part of the latter formation is divided off by clayey beds. The supply at Hunstanton Waterworks, close to the base of the chalk, may, therefore, be derived from this composite source, whereas the supply for the Sandringham estate is from the chalk, the clayey chalk marl coming in at that part, and causing an outflow from the more permeable beds above.

The maps which form the text on which this paper is founded, though based on the later geological maps (with drift), follow the latter absolutely in only one particular, that is in the area coloured as bare chalk. As, however, the object in constructing the maps in question was contrast and conspicuousness, their colours are quite different from those of the geological maps ; and, whereas, on the latter the chalk is shown by a very pale green tint, on the former it is emphasised by light carmin. It is only fair to the maps to say that they were not made as diagrams, to be seen at a distance ; but to be examined more closely, and that they have been coloured at various times, as *occasion* enabled me to take them up. When the work

has been further extended, and a large set of maps can be coloured at once by a better colourist, a more harmonious effect may result.

We may now consider the evolution of these "Chalk Area Maps" from the Geological Survey Drift Maps. It will be at once seen that the geological maps are the far more complicated of the two, having a great number of colours and tints as against the five of the other set. My geological friends may, therefore, be inclined to regard the evolution as a case of degeneration; but, perhaps, engineers may not object to the comparative simplicity of my maps, and to their disregard of theoretical considerations and of geological classification. It should be clearly understood that these maps are meant to show one thing only, that is the accessibility of the chalk to surface-water: they do not always show of necessity the nature of the surface; but their colours are, in some parts, quite independent of what occurs at the surface, which may be neutralised, for our purpose, by something else that occurs beneath.

1.—Bare Chalk.

As in this case the maps follow the geological ones, there is no need to say more than that bare chalk is taken to include those parts where there is merely a thin soil over the chalk, for that soil is practically unimportant as regards water being pervious.

2.—Chalk covered only by Beds of a Permeable Kind.

This includes tracts marked by many colours on various geological maps, permeability being by no means connected with geological age. In colouring these tracts, it was essential to consider not merely the beds shown as at the surface on the geological maps, but to make certain that nothing came between any bed of a permeable character and the chalk, as it is clear, for instance, that ten feet of clay in or beneath 100 feet of sand would stop the downward passage of water through the sand.

The geological beds that fall into this class are as follows: but it should be understood that this is only where one of them rests directly on the chalk, without any bed of an impermeable or mixed kind coming between, or where two or more of them succeed each other without any intervening bed of another kind :—

Thanet Beds, where these are of sand, as in Surrey and West Kent.

Oldhaven and Blackheath Beds, in the few places where they have cut through the under-lying Woolwich and Reading beds, and rest on the Thanet sand or as outliers on the chalk.

Red Crag and Norwich Crag, where they rest on the chalk. Parts of the tracts coloured with the latter on the geological maps are not included, however, on account of the occurrence therein of the clayey Chillesford beds, which must stop the downward passage of water.

Sands and Gravels of the Glacial Drift.

Sands and Gravels of the River Drifts.

3.—Chalk protected by Beds of Mixed or Varying Character.

In this case it is not essential either that the chalk should be directly covered by beds of the kind indicated, or that such beds should be at the surface; it is only needed that they should occur somewhere between the surface and the chalk, and that no absolutely impermeable beds should come in; permeable beds are of course made of no account by the presence of these mixed beds. Many colours of the geological map find themselves massed in this set, as may be seen from the following list :—

Thanet Beds, where to a great extent clayey, as in East Kent.

Woolwich and Reading Beds, from their varying character, here clay, there sand. There are places, however, where it may be well to include this series with the impermeable beds. The overlying Oldhaven and Blackheath beds, in themselves permeable, are almost wholly carried with this

underlying series, except where, as above noted, they have cut through the latter.

Loams of the Glacial Drift. Some of the brick-earth of this age is so clayey, however, that it has been classed as impermeable.

Loams of the River Drifts.

Brick-earth and Clay-with-flints of the high chalk tract. These are beds which commonly occur over the chalk hills, and which, though of a more or less clayey nature, seem not to be wholly impermeable, for they do not give rise to drainage-streams; moreover, they seem, in part at least, to be the result of the dissolution of the chalk by the infiltration of acidulated water. Some outlying patches of sand in East Kent have been classed with these deposits, as they often have a clayey base.

Alluvium.—The silt and peat of our marshes might be thought to be impermeable; but though this may often be the case, these deposits are sometimes sandy, and sometimes very thin, the permeable gravel beneath coming up near the surface.

4.—Chalk protected by Impermeable Beds.

Here, again, as with the last division, the beds in question need neither rest at once on the chalk nor form the surface; their occurrence anywhere between the surface and the chalk is decisive, and relegates the tract where they occur to what, from our point of view, may be called the useless division, save for those parts of it where the surface waters flow towards the chalk. The large tract marked by the grey colour on the maps, owes its classification almost wholly to the two great clay deposits, the London clay and the boulder clay; but some other beds contribute slightly, as shown by the following lists.

Woolwich and Reading Beds.—In North Suffolk, and in Norfolk, where these beds are quite masked by drift and crag, never cropping out to the surface, they seem to consist chiefly of clay, as proved by well-sections, and it is best to class them with impermeable beds. This may

have to be done in parts of the Hampshire basin also, when the re-survey of that tract for drift enables us to construct chalk-area maps of it.

London Clay.—As it is not only where this thick mass of clay forms the surface that it stops the downward passage of water, but also wherever it underlies other beds, it follows that all the overlying permeable deposits have now to be classed with it. This includes the whole of the Bagshot series, so largely composed of sand, which forms such large areas in both the London and Hampshire basins, and also the whole of the very local Coralline crag, which occurs only over a few square miles of Suffolk. Great part of the red crag and of the various drift sands and gravels are also included. All such tracts of permeable beds over London clay, are, of course, of some importance as regards water supply, on a comparatively small scale, and over part of Norfolk and Suffolk no other source of supply from wells is used.

I need hardly say that, in the case of the London clay, my maps add nothing to our knowledge, the position and extent of that deposit being well known, except in East Norfolk and the adjoining part of Suffolk: the above remarks have been made merely to explain the grouping of other beds with it. There are places where the loamy beds at the base of this clay may be sandy enough to allow of the downward passage of water, but such areas must be insignificant.

Brick-earth of the Glacial Drift.—In some parts this deposit is not only of fair thickness, but also of an essentially clayey nature, so that it has then to be classed as impermeable. It often, too, extends underneath deposits of a more permeable kind, and so cuts off their water from the chalk; the underground extension is, however, sometimes hard to trace.

Boulder Clay.—This not only covers the chalk, or permeable beds overlying the chalk, over large areas, but also extends under some of the drift gravels and sands, so that it has a great effect in protecting the chalk from the access of

water. A good example of this is given by one of the maps exhibited (sheet 50, S.W.), in which, on an ordinary geological map (without drift) nearly the whole of the 205 square miles represented, would be coloured as chalk—a most delusive thing, as, in fact, the area of bare chalk therein is very small, and the areas of chalk covered by permeable or mixed beds not large, whilst the protecting cover of impermeable beds spreads over by far the greater part.

The map to the north (50, N.W.) is much the same, though we have here rather more bare chalk; but in this sheet the whole area would be coloured as chalk, on an ordinary geological map, except for the alluvium of the streams.

A larger map, not yet coloured after the plan described (on account of the drift edition not being published) is also a case in point, for, in sheet 47, whilst about half the area (of 820 square miles) is shown on an ordinary map as chalk, the impermeable boulder clay occurs over the greater part thereof, and quite alters the character of the district.

Though for the most part a fairly stiff clay, there is one tract where the boulder clay is so largely composed of chalk, almost to the exclusion of anything else, that one can there hardly take it as absolutely impermeable. I allude to the north-western part of Norfolk, where the thin boulder clay of the higher ground is so like the merely weathered surface of the chalk that the officers of the Geological Survey often had some difficulty in dividing the two, especially in places without clear sections. In other parts of North Norfolk, too (near Wells), the glacial brick-earth seems to be represented by a bed which is little else than reconstructed chalk, the specimen having yielded, on analysis, no less than 91 per cent. of calcic carbonate, the other constituents being, moreover, of a sandy rather than of a clayey character, and the whole having some likeness in composition to parts of the chalk.

From what has been said, it is clear, I think, that the "maps of chalk areas" exhibited are not merely another version, or condensation, of the Geological Survey maps,

although depending so largely on the possession of these. They show, indeed, some things not shown on the geological maps, and for which approximate lines had to be drawn, and their grouping of the facts mapped is different from that of the geological maps.

It may be of interest, perhaps, to contrast the areas of chalk, &c., as shown by some of my maps, with those represented on geological maps without drift.

Thus, in sheet 7, whilst in the latter map nearly half the area, or roughly about 400 square miles, is coloured as chalk, half (or a little more) being of tertiary beds, and a small area (in the north-western corner) of beds below the chalk, a measurement of the four different kinds of area, described in this paper, gives the following approximate figures, which seem, however, to err a trifle on the side of excess :—

Bare chalk	about	125	square miles.
Chalk covered by permeable beds . . .	„	88	„
Chalk protected by mixed beds	„	180	„
Chalk protected by impermeable beds (almost wholly London clay, there being but little boulder clay over the chalk here)	„	430	„

Again, in sheet 46, S.E., almost all coloured as chalk on the ordinary plan, we get the following figures, as before erring slightly in excess :—

Bare chalk	about	76	square miles.
Chalk covered by permeable beds . . .	„	39	„
Chalk protected by mixed beds	„	67	„
Chalk protected by permeable beds. . .	„	27	„

In 51, S.E., where neither tertiary beds above nor older cretaceous beds below occur, but chalk alone, the figures are about 40, 8, 1, and 155 respectively, various beds of drift (especially boulder clay) generally covering the chalk.

Whilst the general result of the work is to curtail the somewhat excessive estimates that may have been made in bygone years of the amount of chalk area available for the absorption of rain, yet the chalk remains our chief water-

bearing bed in the south-east of England ; for, though not always coming up to some of the sand-beds in permeability or porosity, it is pre-eminent over all other geological formations in thickness and extent of outcrop.

Although beyond the immediate object of this paper, there is one circumstance connected with the question of water supply from the chalk which I can hardly help alluding to from its great importance. The present state of the law, as regards deep-seated sources of supply, is the reverse of encouraging to those who advocate the use of pure well water ; for, by a recent legal decision, in the case of Ballard *v.* Tomlinson, it has been declared to be lawful for any one to pour any filth or noxious matter down his own disused well without any regard to the fact that he may thereby pollute the source from which his neighbours draw their supply! It would be a work of no great difficulty therefore to utterly spoil most well-waters, and this might not only be done by inadvertence, as in the case alluded to, but apparently of malice aforethought. If this is really the law of the land, or rather of the water, there seems to be an opening for law reformers. It is to be hoped, however, that the decision may be reversed in a higher Court than that from which it came. I need hardly say that these remarks apply to all water-bearing beds and not to the chalk only, and, to conclude, I may say the same of the line of observation that this paper brings forward.

WATER SUPPLY IN ITS INFLUENCE ON THE DISTRIBUTION OF THE POPULATION.

By W. Topley, F.G.S., Assoc. Inst. C.E.

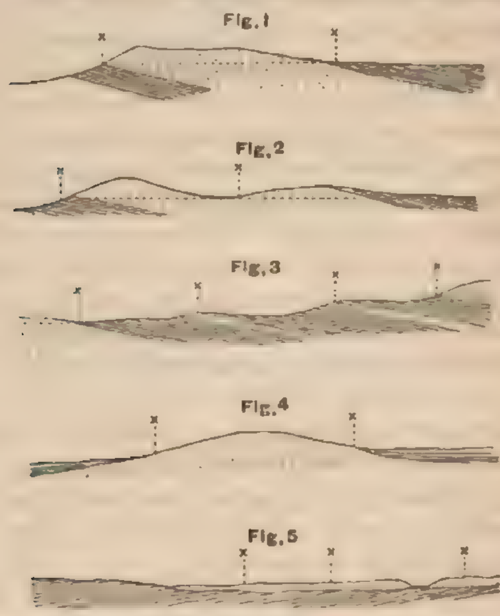
Geological Survey of England. Lecturer on Geology at the Institute of Agriculture, South Kensington.

One of the most essential conditions for the comfort and well-being of a population is water, and a little consideration

will show that the early settlements of a people have been where, and only where, water occurs.

In a broad and general sense, this fact is patent to all—the banks of rivers and streams are usually well populated—the wide areas of waterless districts are unpeopled; but the fact is equally true in a very limited and restricted sense, not at first so obvious.

SECTIONS ILLUSTRATING THE ORIGIN OF SPRINGS.



× × Indicate the mere common sites of early settlements; dots indicate porous beds; lines indicate impervious beds.

The source of all water is the rain which falls on the land; this acts in two different ways, according to the nature of the soil on which it falls. If the soil is porous, or pervious to water, a certain portion of the rain sinks in; if the soil is impervious, the whole of the water either drains off the land into brooks, or passes back by evaporation into the air. The water which soaks into a porous soil or rock, accumulates there until it flows out again as springs, or is artificially tapped, and drawn away by means of wells.

The conditions under which springs most commonly occur may be illustrated by the following "sections," which represent the rocks cut through from the surface downwards. The positions of springs are marked × × ×, and in all cases these also mark the positions in which villages and towns occur.

Springs occur near where a pervious bed overlies or underlies an impervious bed (Fig. 1), or where a valley reaches down to the level at which the rock is saturated with water (Fig. 2). In the case of valleys cutting deeply into the rock, the valleys themselves determine the level of saturation.

A soil which allows water to sink into it is a dry soil, and is therefore suited for habitation and for agriculture. Hence the main conditions which favour the settlement of a district are found in the same soil, or along the outcrop of the same bed. We thus see that geological structure controls the distribution of the population; not only in such great features of the earth's surface as mountain-chains, plains, and valleys, but also in the minor divisions of the district.

The outcrop of a narrow band of porous rocks, between wide beds of clay, is strongly marked by the occurrence of a long line of villages, each of which obtains its water from shallow wells or springs. The cornbrash, between the Oxford clay and the great oolite clays, is an excellent example of this. So, too, is the marlstone rock-bed, between the upper and lower lias. Even a thin and comparatively unimportant bed of sand, ironstone, or limestone, if it only affords a small space fit for arable culture, will be marked by a line of villages (Fig. 3). A thin bed of ironstone in the lower lias of Lincolnshire is a good example of this.

When rocks rise from beneath a covering of clay there are often springs at the junction. Fig. 4 shows a very common arrangement in East Northumberland, where sandstone rises from beneath the boulder clay.

The base of the chalk escarpment, with the line of outcrop

of the adjacent upper greensand, gives another good example. Here the villages always lie thickly along a definite line. There is a well-marked and constant relation between the outcrop of porous strata and the parish or township boundaries, the longer axes of the parishes crossing the outcrops more or less at right angles. A careful study of the distribution of the villages, and of the relation of their parish boundaries to the main physical features, throws much light upon the past history of the country, and often enables us to determine the relative ages of the settlements. This branch of the subject does not now concern us:* we need only note that the arrangement of the parish boundaries depends upon the sites of the settlements, and that these are controlled by the outcrops of water-bearing beds.

The early settlements in England were nearly always controlled by such circumstances as have been here referred to; but the later development of special towns and districts has depended upon a variety of circumstances. In early times it was around some shrine of special fame or sanctity, or under the shadow of the castle of some powerful noble, that the population clustered and the town increased. A little later it was also in places especially well suited for various manufactures. Within the last 200 years the great development of our mineral wealth (especially of coal and iron) has entirely transformed the country. Large towns have sprung up over the coal-fields, often on wide tracts of clay, where few settlements would otherwise have taken place. The natural surface water supply of such places is often bad and small, and the mining operations frequently drain even this.

The water supply of modern towns is, in nearly all cases, either (*a*) obtained from a neighbouring river, (*b*) brought from a distance, or (*c*) obtained from deep wells beneath the town. It thus, except in the first case, differs from that

* For discussion on this question, see a paper by the author, in "Journal of the Anthropological Institute," vol. iii. pp. 32–55 (with maps), 1873

of the original settlement, which always obtained its water from streams, springs, or shallow wells. In far too many cases the primitive source of supply has been continued in use long after the time when it should have been abandoned; and the local source of water supply, essential to the early development of a town, has become a source of danger as the population has increased.

Of the points just mentioned, London affords an excellent example. The old parts of London and its suburbs are built upon gravel resting on London clay (Fig. 5). Where small valleys (such as the Fleet) cut through the gravel, there are natural springs; but everywhere water can be obtained in shallow wells sunk through the gravel. So long as the inhabitants were dependent entirely upon these springs and wells, the houses were confined to the gravel; when a general system of water supply was introduced, the population extended over the intervening area of clay. Meanwhile, the increasing population, without any adequate system of drainage, fouled the shallow wells, and rendered them all more or less impure. It is only within the last few years that some of these have been closed by authority.

Below the superficial deposit of gravel, there are other sources of water supply for London. The strata beneath lie in a basin-shaped form, and thus favour the accumulation of water. Underneath the London clay there are the lower tertiary sands, holding water which rises in the wells when these are sunk through the clay. Still lower, there is the great mass of chalk in which there is an enormous store of water. Still lower, and separated from the chalk by a bed of clay (gault), is the lower greensand. This, on the south side of London, may yet yield some water, but it can never be the great source of supply which was once hoped for.

There are, then, with the river, four different sources of water supply at or beneath London, each giving a different quality of water. Probably no large city in Europe is better situated than London for supplying itself with water from within its own area; but so vast has London now

become, that all these taken together are insufficient, or inefficient.

It is a curious circumstance that some others of the great capitals of Europe are built on "basins" like that of London, and hence are able to obtain deep well-water from beneath. Paris, Berlin, and Vienna, are good examples. This is a circumstance that could not have been known to the early settlers, who concerned themselves only with the surface sources of water supply.

ON A POSSIBLE INCREASE OF UNDERGROUND WATER SUPPLY.

By CHAS. E. DE RANCE, A.I.C.E., F.G.S., F.R.G.S.

Secretary of the British Association Underground Water Committee.

FOR nearly a century the subject of water supply has been constantly before the public, and with the growth of population has become a question of vital importance to the community. The amount of information that has been accumulated is very large, but, investigated by Royal Commissions, inquired into by committees appointed by scientific societies, it is spread over a wide range of literature. It is difficult for any one individual to focus the stores of information already available, still more for him to follow up the numerous lines of investigation these inquiries suggest.

In my work on 'The Water Supply of England and Wales,' published in 1882, I made an attempt to show what was the probable supply of water available in all the river basins of England and Wales, and what amount was required to satisfy the demands upon that supply, with the result that it appears to be amply demonstrated that the rainfall this country receives is more than sufficient to meet all the requirements of human consumption, manufacturing interests, and the purpose of canalisation; and yet, with

these resources, large districts still suffer from all the ills due to a polluted water supply, whilst other large areas are devastated by floods, representing unproductive rainfall passing to the sea.

It is to this unproductive rainfall that I would chiefly wish to call attention in the present communication. Much has been written on underground water supply since the year 1841, when the Rev. James Clutterbuck stated "the extent of the supply must necessarily be regulated by the quantity of rain falling upon the surface, the rapidity with which it is absorbed, and the reduction to which it is subject by evaporation;" but this definition still expresses the knowledge we have on the subject. Rainfall being the sole source of supply to the waters beneath the surface as well as those flowing upon it, accurate information on the amount of rain falling on a district is a matter of the first importance, and this, to be of any value, must represent the observations of an extended period of years, so that not only may the minimum supply to be expected be ascertained, but the average or mean of several successive dry years also. Happily, through the voluntary labour of Mr. Symons, F.R.S., we have now more than 2500 stations at which rainfall is recorded, and we are able, by consulting his annual volumes, to obtain the necessary information for a large number of localities; but it is obvious that, considering the direct bearing such observations have on engineering, agricultural, and sanitary questions, the scope of the inquiry should be enlarged by placing it under a Government department, which could enlarge the scope and usefulness of the inquiry without being, as now, partially crippled for want of sufficient funds to carry out the necessary details.

Pervious or permeable formations, by gradually absorbing waters falling on their surface, which slowly percolate through them, act at once as filter-beds and reservoirs, the capacity of which is limited by the area of absorption, and the thickness of the pervious bed. When rain falls upon a perfectly pervious rock, underlaid by impermeable deposits

the water line is generally near the surface; this line or plane of complete saturation, in sandstone and limestone hills intersected by valleys, is found to be slightly above the level on which the deepest valley intersects the various strata, constituting the water-bearing rock.

When bands of permeable and impermeable rocks alternate, each porous band contains a separate sheet of water, which flows down the dip planes of the strata, confined by the impermeable layers above and below. Such water flows with the head, due to the difference of vertical level, of the area of outcrop to that of the area of discharge, less the frictional resistance of the fragments of the rock through which it passes. When the facilities for the discharge of a volume are less than the quantity capable of being received, the porous rock will be full up to the impermeable layer above, which is invariably the case when all outlet is stopped by faults throwing in impermeable strata, or by the dip carrying the strata beneath the sea-level.

Such porous rocks may be regarded, when provided with an outlet, as underground conduits, the depth of which is the thickness of the bed, the width of which is the extent of the outcrop or horizontal strike of the bed, and the inclination of which is the dip of the strata. Where the outlet is blocked, the saturation-level remains unchanged, and unless water is artificially removed, so as to provide space for a fresh supply, no additional water can be added to the existing supply.

In sinking wells, or in boring into a mass of porous rock, the plane of saturation is found to vary within certain limits, being governed by the amount of previous rainfall. This level, by excessive pumping, is artificially and locally lowered, but the old "rest-level" is restored after a certain number of hours' cessation from pumping. The difference between the "rest-level" and the pumping-level is, in some wells, in porous strata as much 100 feet. The area of exhaustion resembles an inverted cone, the apex of which rests on the point at which the pumps abstract the water, and the base of which is a circle at the surface around the

well. If over-pumping has taken place, the pumps have to be lowered; the cone increases in vertical height, and a larger concentric circle is added to the central one.

In porous rocks of great thickness the plane of saturation is often at a considerable distance from the surface, the annual rainfall absorbed being balanced by the springs run off at low level, and the floods passing across the outcrop too quickly to sink into the strata. In these cases it would be possible to raise the height of the *saturation-level*, and thus increase the storage powers of the rocks by sinking "dumb-wells" in the porous strata, and draining the storm-water channels into them, which would have the effect of increasing the summer discharge of the springs.

From an investigation I made in 1878, as to the area of each of the various rocks in each river basin, which forms the basis of the paper I laid before the Society's Water Congress, convened by his Royal Highness the President, I estimate the area in England and Wales, occupied by porous rocks, to be not less than 26,633 square miles; while the tertiary, gault, weald, oolitic, liassic clays, the triassic and permian marls, and the shales of the carboniferous occupy a further 19,308 miles, in nearly the whole of which occur pervious rocks, a larger portion of which might be rendered available for storage purposes by sinking dumb-wells through the overlying strata, and discharging the land drains into them, which would prevent the water passing away in devastating floods.

Experiments were made simultaneously on the percolation of rainfall by Dr. Dalton, at Manchester, and by M. Maurice, at Geneva. Dalton's gauge consisted of a cylinder, 10 inches in diameter, and 3 feet deep, open at the top, closed at the bottom, and filled with earth, and sunk to the ground level; his experiments were carried on from 1796 to 1798, 25 per cent. of the rainfall being absorbed. M. Maurice's observations, from 1796 to 1797, gave 39 per cent. of percolation. Mr. Dickenson's, from 1836 to 1843, gave 42 per cent. Mr. Greaves' observations, extending from 1852 to 1873, with an average rainfall of 25·8 inches, gave the per-

colation of 26·6 per cent., his gauge being a slate box with an area of one square yard, a yard in depth filled with soft earth, loam and gravel mixed, trodden in, and turfed over. Mr. Greaves states, "the gauge stands at Lea Bridge, 1½ miles west of, and 6 miles north from the meridian of Greenwich." He finds the abundance of water in a river to be more closely dependent on percolation than on mere rainfall; for consecutive months there is no percolation whatever; five times there was no percolation for six months; and only in one year (1860) was there percolation every month. The greatest percolation is after thaws of snow, especially after frequent thaws of small falls of snow. A wet winter gives abundant springs in the following autumn; but if that be followed by a dry winter, it will obliterate the effect of the previous wet winter; this is the case in the present season, 1884, when the springs are remarkably low, as has been pointed out in the *Times* of June 7, by Mr. Baldwin Latham.

Mr. Greaves's experiments show the smallness of percolation through earth on the whole, and its entire absence during warm summer weather; and they also show the small thickness of earth under which water may be safe from evaporation, which he places at a depth of 36 inches; and even at 24 inches he considers it doubtful "whether, in the latitude and temperature of London, capillarity has more than a negative action beyond 12 inches in depth." Probably, in a moderately open soil, capillarity extends only a few inches, but the higher capillary power of clay soil causes a constant summer exhalation. From these facts it is evident that the more thoroughly a soil is underdrained, the nearer it resembles the "percolation gauge," and the less likely is water to pass off as flood in an open watercourse. The more free drainage is promoted, and the more "dumb wells," or "inlet drains," are constructed, the greater will be the quantity of water stored; in other words, the percolation period, ending naturally in February or March, will be artificially extended so as to catch a large proportion of the summer rains; and "intermittent

springs," which are dependent not on surface-present rain, will be increased in volume, and to some extent rendered more permanent, at times when the heavy rains of summer, through excessive evaporation, are adding nothing by percolation to the underground stores.

The investigation of individual observers, and the ten Reports of the Underground Water Committee of the British Association, which I have drawn up, as Secretary of the Committee, have made well known the large quantities of water now pumped from the millstone grit, the permian sandstone and triassic sandstones, the oolites, the greensands, and the chalk; towns like Liverpool, Birmingham, Birkenhead, and Nottingham, receiving from the triassic sandstones quantities reaching, in the case of the city of Liverpool, 6¼ million gallons per day; while the analyses of the Royal Rivers Pollution Commission, show us the pure quality and great value of these waters from a sanitary point of view.

In England and Wales, the pervious portions of the carboniferous, the secondary, and tertiary rocks, occupy an area of not less than 26,600 square miles, while an additional area of 19,000 square miles exists of rocks of this age, which, though impermeable and carrying off the rainfall in floods, yet overlie pervious strata that might, to a great extent, be made available for storage purposes, were dumb-wells carried into them from the surface; such dumb-wells would artificially act as do the swallow holes which feed the chalk and carboniferous limestone waters.

In the chalk, though water is absorbed with great rapidity, and retains a quantity, according to the experiments of Professors Ansted and Miller, equal to one-third of its bulk, it parts with it with excessive slowness; and the water available to feed springs, and to supply well-borings, is mainly due to free water passing down the cracks and fissures which traverse the chalk surface in all directions, the larger fissures allowing the passage of rain water down to the lower portions of the chalk. That the deep-seated impermeable beds occurring at the base of the

chalk formed the surface on which the passage of water chiefly took place, was pointed out by Professor Prestwich, in 1851; and the gradient on which water stands in the chalk was described in the Sittingbourne district by Mr. W. Bland, in 1852, which gave an inclination of 47 feet per mile of fall in one direction, and 45 feet per mile in the other; in Hertfordshire, the average inclination between Dunstable and Watford was found by the Rev. J. Clutterbuck, in observations extending from 1842 to 1850, to be only 14 feet per mile. The later observations of Mr. Baldwin Latham on this subject show the remarkable increase of gradient, produced by the temporary rise in the water level of the hilly districts of the chalk, after heavy and continued rains, which becomes gradually depressed after their cessation, before the springs in the low ground have ceased to give their maximum yield.

Over the whole of the area of 26,600 square miles, drawing wells may be sunk with advantage, and their supply increased by sinking inlet or drainage wells to carry into the strata water now almost entirely lost, and rendered not only unproductive of good, but the agent of actual harm, in the destruction of property and agricultural produce by floods. Care will have to be taken that, in constructing such dumb-wells, communication is not set up between drains carrying objectionable matter and the underground sheet of water, and that in draining wells and bore-holes the point at which the water is abstracted is sufficiently removed from the surface to insure the water having naturally filtered through the superincumbent strata.

In the case of the 19,000 square miles of impermeable strata overlying pervious strata, for the most part already containing water absorbed, in the area of outcrop of the pervious, Artesian borings will give large supplies, in numerous districts where no attempt in this direction has been made; and where the Artesian gradient, or water level, is not as high as the base of the impermeable stratas overlying the permeable bed, dumb-wells may also be sunk with advantage, and in relieving the clay beds of their

floods in winter, will help to increase the summer discharge of the rivers, and render the intermittent springs of more permanent value.

WATER FROM THE CHALK.

By JOSEPH LUCAS.

AT the first Congress on National Water Supply, convened by the Society of Arts in 1878, I had the honour to read a paper indicating an opinion "that the real stumbling block to the practical solution of the water question of the country in general is not, as has been alleged, its cost, but the general absence of data respecting its sources," and advocating a survey of the water-bearing strata on principles described in the paper, and which I now reiterate.

The proposition met with the support of water engineers, and was endorsed in a leading article in the *Times*, summing up the results of the Congress.

At the next meeting in 1879, at which the Council of the Society of Arts did me the honour to confer upon me their silver medal for a paper on "National Water Supply," in a second paper, entitled "Watershed Lines," I gave the measurements in square miles of the apparent and real areas of chalk country lying within the basins of thirteen rivers between and inclusive of the Medway and the Meon, in South Hants, as determined by my hydrogeological surveys.

In the following year, the Institution of Civil Engineers, who had previously published a map and paper giving the results of a somewhat crude survey of the chalk water system (1872–6), did me the honour to publish a map and paper descriptive of the "Lower Greensand Water System of Surrey and Hants." For this survey the Council of that institution awarded a Telford medal and premium. In its application to the subject of London water supply, the hydrogeology of the question has frequently been called

into requisition by the water companies, and was mentioned on the Committee of the House of Commons on London Water Supply, over which Sir William Vernon Harcourt presided, in 1880, by Professor Thorold Rogers, and in the evidence of the late Mr. E. J. Smith. That Committee never got beyond the financial view, and the question of London water supply was practically hung up to await the creation of a Municipal Corporation.

As it appeared to me unfortunate that the survey of the source of water supply should be hung up with it, I have continued to the present time (with the exception of a few months in which I was laid up from ill health) to extend, over large areas, the series of field observations which I have now carried on for nearly twelve years. These materials are in frequent use as evidence before Parliamentary Committees, in the Law Courts, and in arbitration cases at the Surveyors' Institution. As regards special areas, my friend Mr. Baldwin Latham has for years taken a large series of gaugings of wells and streams daily, which are probably unique in this country; and my former colleague, Mr. De Rance, has long edited a collection of observations under the auspices of the British Association, which will be of great value.

This is not the time to go into details of any particular areas, but I may be allowed to present one or two facts from a large mass of unpublished material, in support of any contention that a comprehensive and uniform survey of the sources of water supply is the stimulant required for the flagging water question.

The chalk of the county of Hertford is covered by a varying thickness of drift clay and clay with flints, and the wonderful plains of gravel that occupy nearly all the upland surfaces. From surveys made in 1876–7 and 1884, I have traced out two distinct water systems—one, the deeper, that of the chalk, which at the present time lies far below most of the valley-lines in the chalk basin of the Lea, and another, that of the surface gravels. Many of the various tributaries now in water are surface streams only,

and here and there plunge into the chalk beneath. There should be no difficulty in supplying any village in the county, yet such considerable villages as Reed, Kelshall, and Sandon, have no well, and are dependent on ponds, which before the storm of July 9th were reduced to the last extreme of filth.

Essenden is also without a supply, and is under notice from the Rural Sanitary Authority; but I am told by a member of the Board that they have no knowledge how to supply themselves. As compared with some other chalk counties, there are no very deep wells in Hertfordshire. Along the base or boundary of the tertiary clays it occasionally happens that the drainage of considerable clay surfaces is discharged into the chalk, either by large swallows, as at Farnham, South Mimms, and Chislehurst, or by invisible leakage. Such points afford grand opportunities for collecting water, a fact that has not been lost upon the Kent Water Company at Crayford and Chislehurst, and might be turned to useful account elsewhere.

The chalk of the South Downs presents one or two notable points. Taking the geological unit of some 45 square miles area, between the Arun and the Adur, which it was my privilege to survey in the winter of 1878–9, and the summer and autumn of 1883, the water system shows three basins: one draining west, towards the Arun; another east, towards the Adur and coast; and a third, the Finden basin, between the two. The extreme height of the boundary water ridges of the Finden basin, under the escarpment at Sullington Down on the west, and Chanctonbury on the east, is 300 feet: the distance from the rivers, west and east, which run in at mean tide level, being respectively 4½ miles and 3 miles; and distance from the sea 6 miles. On a cross section of the intermediate or Finden basin, from Sullington Down to Chanctonbury, we find a fall under the valley of upwards of 200 feet in the water line, the water not attaining 100 feet above O.D. at 6 miles inland along the valley. In the Michelgrove basin it falls short of 20 feet above O.D. at 5½ miles inland, under

the valley, while 1½ miles to the west it attains 257 feet. A third case is at Lychpole, where, at 3 miles from the coast and the Adur, the water falls to 6 feet above O.D. I have met with no other area which exhibits such clearly defined channels underground as the block of chalk between the Arun and the Adur.

The upper greensand, generally a slender source of supply, presents a notable exception. In June, 1882, I was invited to make a survey in search of a supply for the town of Warminster, and in the course of a few days was surprised to find some abundant springs issuing above Sheerwater Lake.

(1.) Sheerwater Spring Pond, discharging 132 cubic feet per minute (or twelve times the requirements of the town) at an altitude of 476 feet O.D., and 68 feet above the highest point in Warminster. (2.) Glasswell Spring, discharging 7 cubic feet at an altitude of 482·79 feet O.D., or 74·74 above Warminster. (3.) A spring rising in boggy ground at Aucombe, discharging 55 cubic feet per minute. This spring I did not recommend, as it is muddy and peat-stained. The total discharge of Sheerwater Lake was 200 cubic feet per minute, or vastly in excess of all the above which flow into it. The elevated situation of these fine springs places them out of the reach of contamination, an advantage enjoyed by few towns in England. In the case of Warminster it is the more remarkable, as that town stands on the watershed ridge between the two channels. The Local Board is now taking steps to acquire water from them for the town. It is important to note that the mill-owners of the Alyn, last year, failed to establish their claim to compensation in water for the quantity proposed to be abstracted from that flowing down the Silurian mountains on to the mountain limestone in which it sank, before a Committee of the House of Commons. Gaugings were specially taken last July, a temporary dam being formed above the inflow, and suddenly removed to let down a rush of water, which was found to issue a quarter of a mile below, after which it again sank and re-issued. This

decision affects several English rivers and streams. Hydro-geological evidence is of the utmost importance in all such cases.

I must call attention to the recent decision by Justice Pearson in the case of "Ballard *v.* Tomlinson" (I being a witness as to facts below ground on behalf of the defendant), that the owner of a well is at liberty to pour sewage, or arsenic, down it if he likes, and to suggest that there is need for a change in the law upon this point, which will become more important if London should ever (and the attention of Sir Francis Bolton should be called to this point) draw more largely than at present from the chalk, as would appear possible after the recent demonstrations of Colonel Beaumont's rock-boring machine in the Channel and Mersey tunnels, and the Halkyn drain in the mountain limestone.

In conclusion, I trust that the present Conference will not break up without passing a resolution to the effect "that a national survey of the sources of water supply, both surface and subterranean, to produce maps defining levels, areas, and quantities of water, should be set on foot by Her Majesty's Government with the least possible delay." I trust that the spirited perseverance of the Society of Arts will be rewarded by a practical outcome from their several Conferences.

DISCUSSION.

Mr. HENRY ROBINSON said he feared, without some further explanation, that the allusion made by Mr. Lucas to the decision of the Parliamentary Committee, not to give the millowners on the river Alyn compensation for water abstracted, might be misunderstood. He was engineer of the Bill before the Committee, and the facts were these. There was a petition from the millowners, asking that the company should give what was regarded as

the usual clause, providing that a certain amount of water from the gathering ground should be sent to the stream, but the Committee were of opinion that it was not sufficiently proved that a large volume of the water which went into the river Alyn was connected immediately with the gathering grounds from which the company were to take their supply. There was a doubt whether a large portion of it did not disappear in a swallow, even at the present time; and as regarded the future, the Halkyn level, which had been referred to, having been authorised by Parliament, was in course of construction, for the purpose of draining a large area of mining grounds; and therefore it was put before the Committee that a large body of water which was part of the river now, would cease to be so. The case, therefore, was exceptional, and could not be relied upon as a precedent for other cases.

Mr. CONDER said he noticed in the four papers which had been read an echo of what was stated in 1878. A number of individual projects were then brought forward, and, to a certain extent, much harmony appeared to prevail on that occasion. Before those projects were entered upon, he ventured to submit to the meeting that, being so far in accord, it would be well to put their accord on record, and to pass a resolution which might be taken as the unanimous opinion of the Conference. With some little modification that plan was adopted, and the result was an application on the part of the Conference, in 1878, to His Royal Highness the Prince of Wales, to suggest to the Prime Minister the appointment of a small Scientific Commission for ascertaining those facts, which they were now told still required to be made known. The application was made, but through various circumstances was put aside, and nothing had been yet said which did not tend to show the weighty nature of the application. And he would venture to submit whether it would not be a worthy outcome of the present proceedings to repeat the recommendation of the former Conference, and endeavour to obtain further distinct and definite information as to the

subject of water supply. The contrast that existed between the information, or rather want of information, on this subject, in this country and on the Continent, was anything but creditable to us. They owed something to the Ordnance Survey, and they owed much to several gentlemen who had devoted themselves to this subject. It was impossible to touch the subject at all without acknowledging what they owed to Mr. Symons for the information he had collected with regard to the rainfall. That information had been collected, in the first instance, by his unassisted efforts, and afterwards by the efforts of an unpaid and disinterested body of fellow workers, which were an honour to the country, but possibly not so much an honour to the Government that such a duty should be left on the shoulders of private individuals. The Blue-books which had been issued by the different Commissions contained a mass of information, and so did the proceedings of the Institution of Civil Engineers. But when they turned to other countries, a very different state of things was to be found. The Italian Government published, in a form accessible at a small cost to every landowner, information as to the flow, both in summer and winter, and all the other particulars of every river in Italy. But if we turned to our own books and proceedings, there was an absolute absence of this fluviometric information which in Italy was at the command of everybody. He need not point out how important it was to the engineer and landowner, or to any one who had to keep off floods, or seek for water, to possess all this information; and therefore it was not merely as an academical demand, but as a matter of practice, that this knowledge was required. Many of them were aware of the present condition of the Thames, and he apprehended, from instructions recently given by the Board of Trade, that they would shortly be in possession of the actual summer flow of the Thames during July. The lowest account of the flow was that of Mr. Harrison, who put it at 309 million gallons per day. Mr. Bateman put it at 350 million gallons as the summer

flow, for days and days together. But the question was whether, with a long series of dry years which might naturally be expected to follow the long series of wet years we had had, a constant supply of 350 million gallons could be anticipated. On the other hand the demand was constantly increasing. The quantity pumped in July, last year, by the five metropolitan water companies, exceeded 75 million gallons per day; and considering that in the Valley of the Thames, not including that of the Medway, there were now something like seven millions of inhabitants, who require 225 million gallons a day, that was making an unpleasant approach to the 350 millions of possible flow. In forty or fifty years, those seven millions would have increased to something like 14 millions, and the 225 million gallons required now would be from 400 to 500 millions. It was tolerably clear, therefore, that it was desirable to know all that was to be known about the sources and the behaviour of the Thames. With regard to dummy wells, it was a local question how far any individual well might absorb a flood, but as to the general idea, he thought all would agree it was a feasible and good one. There was one point to which he would call the attention of practical men which had not yet been touched upon. The Valley of the Thames and Medway included an area of something like 6000 square miles, or 5000 for the Valley of the Thames alone, and of this, according to the figures, something like 4000 miles was a permeable area, of which 2000 were chalk and 2000 miles sand and gravel—a true water-bearing area. The great object of the Geological Survey was to avoid wasting flood-water. The natural storage of this water was the pervious water-bearing beds, and the importance of the information suggested as to the percolation from the surface was no doubt very great. They had the facts of the rainfall, and of course they could get nothing more than the rainfall. About fifteen inches evaporated in the course of the year, which would leave only eleven inches to be dealt with in the Thames Valley, of which it was supposed two or three

ran down the river Thames. But in whatever mode the water got into the water-bearing strata, there was no doubt it escaped from it very irregularly. It escaped at the lowest lip of the basin, and if a thorough knowledge of the basin were obtained, it occurred to him it would be possible to raise the lip, and place a regulating sluice there, and by that means, to store one, two, or three years' of rainfall in these water-bearing strata, to be drawn upon as required and so keep up the flow of the Thames.

Mr. BALDWIN LATHAM said, with reference to the escape of water from the outcrop of the chalk formation, it was quite clear that all round the escarpment of the North Downs a very small quantity flowed away in the opposite direction to the dip of the strata, which was towards London; in fact, immediately under the chalk there was the upper greensand, which all along the escarpments was worked, at various quarries, both for building and fire-stone; and the level of the water in those quarries varied with the level of the water in the overlying chalk formation; and although there appeared to be the chalk marl intervening between the upper greensand and the chalk, he did not think it was of such an impervious nature as to prevent direct communication between the waters of the two strata. In fact, it was clearly shown where the chalk marl came to the surface all along the foot of the escarpments of the North Downs, there were no ditches or streams all along the formation, and all the rain equally disappeared there as it did over the chalk itself; therefore, practically for all water supply purposes, the chalk, with the chalk marl and upper greensand, might be taken as one stratum. There were immense fluctuations in the quantity which was stored from year to year in these formations. In March, 1883, they had one of the largest quantities of water stored in the chalk of the North Downs and South Downs which had been known for many years, and yet at the end of 1883 they had one of the lowest water periods. That was a thing which had hardly ever occurred before—going from extreme high water to extreme low water in a

single year. The maximum probably exceeded the minimum by ten times, and, therefore, when considering the water supply of a particular district, the minimum must be borne in mind, and either the average or the total capacity, seeing there were these immense fluctuations in the quantity of water which were common to all geological formations. The same thing occurred in the new red sandstone, the permian beds, and the oolite, in all of which he had carried on observations for some years. It was absolutely certain, therefore, as Mr. Lucas had pointed out, that a future water supply for underground sources must depend upon correct hydrogeological surveys. When the quantity of water was known, and they could show the yield over certain years, and what area of strata was required to supply a definite quantity of water, there would be nothing to do but to make careful observations in order to get a sufficient supply of water. The question of compensation would naturally crop up, and to his mind there was not the slightest doubt that a single drop of water could not be taken from any of these porous strata without interfering with the flow in some adjoining stream. It seemed, therefore, to be a matter of great injustice that power should be given to water companies to sink wells and abstract water to the injury of those who had property, and often very valuable property, in the water supply, without compensation. The hydrogeological experiments which had been made would tend to show that these areas which were affected contributed their supplies to different rivers, and when it was essential to the public advantage that supplies of water of this character should be procured, it was only right that those who were injured should be properly compensated. With reference to Mr. De Rance's proposition as to the means of storing water in porous strata, of course there were great difficulties in the case of elevated strata, but there were other circumstances in which water might be stored in that way. In the course of his investigations, he had received the most valuable contributions from General Hyde, of the

Indian Railways Department, who stated that in Peshawur, from time immemorial, it had been the practice in the rainy season for the natives to cut channels from the water source to the wells so as to fill up the gravelly strata underneath the more impervious surface stratum, and when the wells were filled in that way they were closed, and only opened in the summer time, so that they had at that period an abundant supply of water which had been cooled by coming in contact with the earth at the time at which it was stored. Therefore, what might appear to be a new idea, was really one of extreme antiquity. The whole question of water supply was one of the greatest importance with regard to the public health, and it behoved them, especially in seeking for these underground supplies of water, to take care that they were sought for at points not liable to contamination. Many underground sources of water supply were polluted to a frightful extent; and really the cause of his undertaking these investigations was the repeated outbreaks of typhoid fever in the district with which he was especially connected. Having been able to collect statistics for some fifty years back, he could say with confidence that there was the most marked parallelism between the state of the underground water and typhoid fever. Not only so, but these statistics showed very clearly that there appeared to be a ten years' periodicity in low water times. One of the lowest water periods in this country occurred in the cholera year of 1854; another very low water period occurred in 1864, and another in 1874; and two years ago he predicted, as the result of investigations, that there would be a low water period this year. There was not a shadow of doubt in his mind that over a large portion of England we should have the water lower this year than it had been for years, and the consequence would be that the diseases which followed those periods were likely to be more rife than they had been for some time past.

Mr. W. SMARTT said he understood that the water at Birkenhead was contaminated in a very serious manner, and

knowing that a patent was applied for not long since, for a method of draining land in a particular manner into the chalk, he thought it was hardly advisable to go to any great expense in taking water from the chalk, seeing that there was a danger of its being seriously contaminated. Laws might be passed to prevent the passage of drainage from houses into it, but if the level of the water under London were lowered to any great extent, it was quite possible to cause a flow back from the lower part of the river. For instance, there was said to be a fault in the chalk at Woolwich, and on a former occasion it was stated that the water supply at that place was frequently contaminated from that cause. There were also faults under the Thames, and if the water were lowered, there would be a flow back which might not be noticed for a considerable time, and eventually the whole body of the chalk water might become contaminated. There could be no doubt that the water was absorbed by the chalk beyond the amount absorbed in the first instance, for having placed a piece of chalk in water, and allowed it ample time for absorption, and then placed it in a vessel where it remained for some time, he found that not a particle of water ran out. His opinion was that water should be taken from the springs along the course of the river, whilst it was still pure. The water could be obtained at a depth of 30 or 40 feet all the way up the valley of each river, and it might be taken out of the chalk or other porous strata. It was shown that about half of the chalk district about London was covered with an impervious stratum, though the surface might be pervious, as it was reasonable to suppose it would be, because all the marsh land was flat, showing it was formed from sediment washed down from the hills, and being washed down gradually, it must necessarily be more or less porous, and contain a large quantity of water. With regard to swallow holes, it had been stated at a former meeting that there was a passage in Lincolnshire extending some miles under land, and out to sea.

Mr. JOSEPH QUICK, jun., said, referring to the statement

of a previous speaker as to the condition of the Thames being at present so extremely low, that only 350 million gallons a day passed over Teddington Weir, he knew that information to be perfectly accurate. The question he wished to ask was, why advantage was not taken of the enormous quantity of water which flowed at other periods over the weir, and which, so far from being useful, was, on the contrary, a very serious detriment to navigation? If those responsible for the water in the Thames stored up the winter floods, they might thereby regulate the flow throughout the year, and the condition of the river would be much improved, with advantage not only to those who took from it, but to those who lived on the banks. With regard to the case of the river Alyn, he had the misfortune to be opposed to Mr. Robinson before the Parliamentary Committee, but he certainly thought Mr. Lucas went a little too far in saying that the decision of the Committee formed any precedent for future cases, and that millowners were not to be compensated for water of which they were deprived by water companies or others. The circumstances were quite exceptional, but the Committee did not lay down any precedent to prevent millowners in future cases asking for water compensation.

Mr. W. B. KINSEY desired to corroborate Mr. Baldwin Latham's remarks with regard to the question of periods of drought. From his own investigations he found that ten years ago there was a drought, and again ten years before that, and there was the same drought now. He could also concur in what he said about the water flowing against the dip of the upper greensand. He was now carrying out works in the neighbourhood of Petersfield in the upper greensand, where the facts fully bore out what had been stated.

Mr. W. A. RICHARDSON said he had heard it stated with great surprise that the wells at Birkenhead were polluted. The water at Liverpool was taken from boreholes in the red sandstone, 450 to 460 feet in depth, and the water was frequently analysed, and was considered to be the best and purest in the kingdom.

Mr. LUCAS, with reference to the case of the river Alyn, produced a section showing the exact state of the case, and remarked that what he said in the paper was that it would affect similar cases. The section showed that the water flowing down the slanting strata sank into the limestone and ran a quarter of a mile underground in a course that was not known, and it was on that ground that the Committee refused compensation. Of course rivers which had no such underground course, would not be affected.

The CHAIRMAN then proposed a vote of thanks to the four gentlemen who had read the papers, which was carried unanimously, and the Conference adjourned for a short time.

THE ORIGIN OF WATER SUPPLY.

By G. J. SYMONS, F.R.S.

THIS title might possibly be supposed to imply a history of the past, but in this Health Exhibition, *pace* Old London, we deal chiefly with the present and with the future.

I know no better word than origin wherewith to describe the small portion of the great subject of water supply which I am permitted to discuss.

All water supply comes from the clouds, and it is with the products of the clouds as rain (including therein snow and hail) that I have to deal.

Perhaps before describing the general features of rainfall distribution, it may be permissible to explain (for the use of those who have never done it) how the fall of rain is measured. If we imagine a flat dish—a tea-tray, for instance—placed upon a lawn during rain, it is obvious that (subject to loss by splashing) that tray would at the end of the shower be covered by a layer of water of a *depth* approximately equal to that which fell upon all

portions of the lawn, and the depth of the water on it (say $\frac{1}{2}$ inch) would be the depth of the rain fallen. Obviously, besides the loss by splashing, the water on this tray would soon evaporate and be lost, besides which the depth could not easily be accurately measured. For these reasons, some form of funnel is always used, so that the rain may be, as it were, trapped, prevented from splashing out, and from evaporation. In the gauge before you (a very inexpensive one) all known sources of error are guarded against, and, as the water collected by a 5-inch funnel is measured in a jar only $1\frac{1}{2}$ inch in diameter, it will at once be seen that its vertical depth is multiplied nearly tenfold, and, therefore, even $\frac{1}{100}$th of an inch is easily measured.

There are other patterns specially adapted for observation on mountain tops, where they can only be visited once a month; others for observations during heavy thunderstorms, so as to obtain data needful for drainage questions; others in which every shower that falls writes down its history, the instant of its commencement, its intensity during every minute, and the time of its termination; but I must not stand between you and other papers with a discourse on the many interesting points which these gauges bring out.

During the last twenty-five years, I have done what I could towards establishing a complete system of recording the rainfall in this country. In early days the British Association for the Advancement of Science gave considerable help, but some ten years since they dropped it. Government have never given any help at all, and now the whole cost, or 99 per cent. of it, is borne by the observers themselves, a body which has now grown to the very large number of nearly 3000. I do not know the precise number, but there are every year new stations beginning, old ones stopping, and others interrupted; yet for 1883, I have just had the pleasure of printing perfect records from 2433 stations, every record having been previously carefully examined and verified.

Hitherto, I have been so overworked, and my staff has been so small, that the discussion of the data falls behind the collection; for this reason I cannot lay before you such data as I wish. However, the map on the wall is the one I drew many years ago, and which was inserted in the sixth report of the Rivers Pollution Commission. It is not perfect, but as it is tinted with increasing darkness for places with heavy annual falls of rain, it will at least show you the broad features of the distribution over the country.

I refrain from going into the subject in detail, desiring chiefly that you should realise the fact that large tracts of country have twice and even three times as much rain as others. If we descend to single stations, the differences are of course greater, *e.g.*, in 1883, the rainfall at The Stye, in Cumberland, was 190·28 inches, and at Clacton-on-Sea, in Essex, it was only 18·71 inches; that is to say, the one was more than ten times the other.

Here I should like to interpose a question as to public policy. There is often a great outcry if the water of one district is taken to another. Surely, while there is no relation whatever between the density of population and the quantity of rainfall, one early duty of a Government is to see that all parts are amply supplied with the chief necessary of life. Englishmen have a dread of centralisation, but in many ways they pay a long price for their dread. At present, it is not often that any town can even state before Parliament its views as to the effect upon it of what its next neighbour may be obtaining powers to do. Having suggested one semi-legal question, I may as well mention at once another. Up to the present time, there being no Hydraulic-office (as I hold that there should be) in this country, all the larger water questions come before Parliament as private Bills, and, provided that they get through Committee, they, as a matter of course, become law—law for all time to come. No one can foresee what will be the total population of this country a century hence. No one can tell where the bulk of the people will reside, nor what will be the need for water in various parts of the

country. Water-rights are already very valuable, and they will probably become still more so. Would it be possible to safeguard our successors by insisting that special water-rights, if now asked to be created, shall be subject to revision, *without compensation*, after the lapse of 100 years?

However, to return to rainfall, and explain why I stated it to be the origin of water supply. All rain and melted snow must be disposed of, either by evaporation, percolation, or flow into streams and rivers. The first class, evaporation, is, of course, not a supply, and therefore we must not pursue it. Percolation is the source of all springs and of all well-water. Sometimes, as at Lancaster, the springs are so large, that even a considerable town can be supplied by merely laying pipes to the sources whence they burst forth; sometimes they run into the reservoirs of gravitation water-works; sometimes they pass, as in the chalk districts, for miles beneath impervious strata, finally being either pumped up from wells, or even, in rare cases, rising as true Artesian wells above the surface of the ground; and sometimes they pass even deeper, as in the red sandstone supplies pumped from extreme depths for Liverpool and other towns.

The water which runs off the surface is sometimes utilised by throwing a bank across a stream, and thereby forming a reservoir behind it, as, for instance, in the new supply for Liverpool from the Vyrnwy, where the reservoir will form a lake larger than many of those in Cumberland. Sometimes the lakes themselves are utilised as reservoirs, as, for instance, Loch Katrine and the surrounding lakes, and sometimes, as at York and London, the rivers are drawn from by powerful pumping machinery.

It is often said there are few things so uncertain as the rain. That is both true and false. True as regards our ignorance of the future, false as regards our knowledge of the limits within which the quantity of rain will be found to vary.

There are now hundreds of records of rainfalls in this

country of thirty or more years each, and in a very large majority of them it will be found that the following proportions will be within 7 per cent. of the truth :—

Wettest year, 45 per cent. more than the average.
Driest year, 33 per cent. less than the average.
Driest two consecutive years, 26 per cent. less than the average.
Driest three consecutive years, 21 per cent. less than the average.

There are many other facts respecting the laws of rainfall distribution, concerning which time prevents my saying anything, but I trust that enough has been said to establish the necessity of a perfect system of rainfall registration as the basis of any efficient hydraulic organisation.

DISCUSSION.

Mr. E. K. BURSTAL thought Mr. Symons had made out a very strong case indeed for limiting to some extent the period to which water rates should be absolutely unalterable. They had been accustomed to consider that the three driest consecutive years were one-sixth less than the average, but he now showed that they were one-fifth less ; and as the difference between one-fifth and one-sixth was considerable when dealing with very large quantities, that was a sufficient reason why some such suggestion as his should receive serious consideration.

Mr. LIGGINS wished to point out the great importance of using rain gauges. Some thirty years ago he spent a month in Santa Cruz, and there he found the rain gauge was the first thing which interested the manager of an estate when he got up in the morning. The next year he visited his own estate in the island of Antigua, and found only two rain gauges in a whole group of islands ; but in consequence of what he had seen in the Danish islands, he interested all his friends, from the Governor downwards, in introducing the system. The result was that every estate in the island from that time had constantly

used the rain gauge with great satisfaction. The same course had since been adopted in Barbadoes, and he only wished the farmers of England were as enlightened as the planters of those islands, and would see the importance of having rain gauges on every farm in England. He was quite sure they would be pleased with their week's work when they came to tabulate it, and would find the benefit of the information thus obtained. When there were such divergencies as were indicated on the map, there was a clearly proved necessity that, in every district, they should know what they might expect, so as to guide them as to the desirability of commencing the various agricultural operations.

Sir ROBERT RAWLINSON, C.B., remarked that the rain gauge only afforded part of the information, and that a very imperfect part, of that which was necessary for the engineer in pursuing his practice. The rain gauge recorded the rain that fell into it ; it did not record the evaporation that took place outside of it. In this country a season might have a rainfall which should take place in a certain order, and which would register in the rain gauge a certain quantity of water, but scarcely any of that water would have been available for the engineer. For instance, in this country, after a continuance of dry weather, a heavy shower on the mountainous districts in Wales, or elsewhere in the kingdom, would do very little for the engineer, because nine-tenths of the water would go back into the atmosphere before it got down into any stream to feed a reservoir. That was a fact which young engineers should know. If in the mountains of Wales, for instance, a rainfall of 2½ inches took place in a week, and then stopped, there would be no feeding water for an engineer's reservoir. Then, if an interval of dry weather should take place, and another 2½ inches of rainfall during a week (which would be a tolerably heavy fall), the engineer would have no feed into his reservoir. He could mention one instance where, on the east coast of England, a reservoir which he had himself constructed was run dry, and for twenty months continuously there was no

rainfall in that district which was capable of feeding it. Those were important facts which young engineers must take into account.

Mr. MACKNIGHT, with regard to Mr. Symons's reference at the end of his paper as to legislation being very desirable on the subject, said that gentleman had not told them in what direction the legislation he desired should proceed. For his own part he considered that a great deal of injury had been done to the country and to the public interests by premature and rash legislation on these subjects. He thought a great deal more information was required on scientific points before such attempts were made. In Scotland, in various sanitary matters, a great deal of harm had been done by premature legislation, where persons holding particular views on matters of scientific observation had influence enough to get legislation passed in those directions, and it had then turned out that instead of doing good it had done a great deal of harm. A great deal more information should be before the public and scientific societies before such attempts were made, and he deplored the fact that the country should be allowed to suffer from premature sanitary legislation.

A vote of thanks for the paper was then passed.

WATER SUPPLY TO VILLAGES AND RURAL DISTRICTS.

By EARDLEY BAILEY-DENTON, C.E., B.A., OXON.

Author of *Handbook on House Sanitation.*

I BELIEVE that I am uttering a fact which no one can discredit, when I state that there is no object in social economy which is more important, having regard to the aggregate number of persons affected by it, than the supply of water to village communities and rural districts.

At the present moment, when the International Health

Exhibition may help to draw attention to sanitary objects of varying degrees of importance, it may be well to make clear that the condition of rural districts, in relation to water—the first essential of healthy life—is a positive disgrace to a country represented by a State Department whose efforts, it appears to me, should be specially directed to the protection of small communities less able to help themselves than large ones ; and is a sad reflection on the present advanced stage of sanitary knowledge—an admission which the special meteorological condition of the present season, and a possibility of a visit of cholera, brings home to all minds with increased force.

If it should be understood, too, that the existence of this condition of things is to be traced, not so much to the absence of potable water, or the difficulty of bringing it into use, as to the disinclination of local authorities to develop the capabilities at their command.

It may be said with truth that, as a general rule, Local Boards and Boards of Guardians having jurisdiction in rural districts, who have been called into existence to supply the sanitary requirements of those districts, are animated with less desire to perform the duties devolving upon them than to avoid them. It is indeed notorious that the majority of members of Local Boards are elected under a pledge to oppose such works as sewage and water supply, on the ground that the rates will be increased ; and knowing this to be the case, and that few persons of superior position are willing to take part in Local Boards, because they would invariably be outvoted, it is easy to understand why rural districts should be the last to move in the water question. It is, however, very difficult to explain why the clergyman and medical man of rural parishes, whose higher education should be a guarantee that the right thing would be done, fail to exercise proper influence. If, perchance, they are elected to serve on Local Boards, it almost invariably follows, that the one forgets what he has said in the pulpit as to the influence on the Future of sudden death ; whilst the other ignores the advice he has given his

patients in their sick-chambers, in relation to the fatal effects of inhaling and imbibing those germs of disease which float in foul air and impure water. Directly they are easy in their chairs as members, they content themselves with the *laissez faire* policy of their colleagues.

These influences explain how it is that local authorities abstain from appointing as surveyor or sanitary inspector any man with a capability and courage to expose local defects and requirements, and why, when a medical officer does his duty in explaining the defective character of the water supply of any portion of his district, some reason is soon found for relieving him of his duties, and for appointing another in his stead; the actual result of all this being that the governing bodies of rural and small urban districts exercise their functions, when compelled to act, not by taking the advice and opinion of men technically qualified to guide them, but by the exercise of their own judgment. You may often observe a small publican or a grocer—excellent tradesmen in their respective vocations—directing the sinking of wells in village streets in close proximity to leaky sewers, ditches, or cesspools, by which the water intended for the supply of the poorer inhabitants soon becomes foul and unsuitable for domestic use. So general, indeed, has been this abuse, that it is no exaggeration to state that nineteen out of twenty existing village wells are quite unfit for their purpose, and that if samples were honestly taken and submitted to a competent analyst they would be condemned. Yet they are permitted to exist, and nothing is said about them, because the populations interested are comparatively small, the death rate is not excessive, the dwellings are low in value, and, above all, because the rates would be increased if a proper water supply was substituted.

I have been induced to offer some remarks upon the present occasion, not because I have anything especially new to lay before you, but because the facts I have just referred to, on the constitution of local authorities and the performance of their duties, have been made more pertinent

by the circumstance that, at a time when there exists the apprehension of a visit of cholera, a scarcity of water may occur, owing to a remarkably dry winter being followed by an unusually hot summer, which the recent thunderstorms may not sufficiently counteract. It is unnecessary to explain that the summer supply of water is very greatly dependent upon the fall of rain during the preceding winter, *i.e.*, upon the rain falling in the non-evaporating and dormant months of November, December, January, and February. The mean amount of rainfall in those months of the last winter did not reach two-thirds of the average quantity due to the same months for the preceding 60 years. This deficit would have been much more severely felt at the present time, and would have affected our subterranean supplies much more than it is now likely to do, had it not been in some measure counterbalanced by the excesses of rain which occurred during the last seven years, from 1876 to 1883, which gave us, on the whole, a considerable balance to carry over. This advantage, coupled with the frequent and heavy thunderstorms which have occurred within the last month or two, will go far to prevent the scarcity of water which would otherwise have occurred during the coming autumn; though, unfortunately, this national advantage will be a poor compensation to the agricultural interest, which has suffered so severely from the excessive wetness of the last few years.

Without taking into consideration on the present occasion the use of rain water, which, under careful management, may be collected from roofs, and other impervious surfaces, and stored in tanks, and which will always form a valuable means of supply to private dwellings, and in special instances may be made available even for villages, our rural supply, now so often derived from dirty ditches and shallow wells, more or less polluted by foul matters, may, in the absence of springs, rivulets, and impounded upland surface waters, be obtained from subterranean sources of "wholesome" character. These are to be found in various beds or outcrops of a water-retaining character, which gather

water at a comparatively shallow depth below the surface, such as the post-tertiary beds of Norfolk and Suffolk, and the different drift beds covering the London clay; the Bagshot sands; the green sand overlying the wealden and gault clays; the surface sands and beds of the wealden formation; the calcareous grit and coral rag outcropping between the Kimmeridge and Oxford clays, and other beds of like nature; or, from the well-defined water-bearing strata of the chalk, the oolite, and the red sandstone formations which are deep lying, and to reach which it is often found necessary to pass through superincumbent impervious beds or strata of varying thickness.

From the first source, it requires comparatively little motive power to raise the supply to the height required; in fact, in many cases, the application of the ordinary lift or atmospheric pump suffices; in others, where the depth exceeds thirty feet, additional power is called for. The second source requires more powerful pumping, and may involve the use of several pumps working in unison. All this has been said and explained before. My desire now, is, if possible, through the influence of this meeting, to impress upon Local Boards and Boards of Guardians in rural districts where, in order to obtain unexceptional potable water they are obliged to seek it from beneath the surface, that the experience already gained in tubular wells goes far to prove that, in the majority of instances, the "tubular" system may, with good effect, take the place of the old and more expensive practice of sinking large wells involving brickwork, steining and staging. Economy, important though it be, is however secondary to the more important fact that a tubular well signifies continuous and watertight piping from the surface of the ground to the subterranean water-level beneath, so that the entrance of polluted surface or subsoil water (as is so frequently the case in ordinary shaft wells) is rendered impossible. In addition to this advantage, it should be pointed out that tubular wells are very rapidly made, and can be readily removed should it occur that the water found or sought has not answered

expectations in quantity or quality. Moreover, the whole of the materials employed may be applied, when withdrawn, to the same purpose in another place.

I may here state that there are some few disadvantages attending the adoption of tube wells which it is right at once to refer to. One is that, if owing to accident pumping is stayed, there will be no supply during such time, and if it should happen that the stored supply should run out before the pumping is resumed, much inconvenience may be experienced; whereas in ordinary shaft wells, there being room for more than one pump, such an objection may be obviated. Another disadvantage is that should the demand for water increase beyond the capability of supply the only remedy is to sink others, and to utilise two or more in combination.

To render the nature and cost of tubular wells, which necessarily vary in character and size according to local circumstances, as intelligible as it is possible to make them to rural sanitary authorities, I may shortly state that, adopting for illustration the two characters of the tubular wells already mentioned, *i.e.*, those that can be worked by ordinary lift and atmospheric pumps at a depth of less than 30 feet from the surface, and those that raise water by more powerful machinery from deep subterranean water-levels, the *modus operandi* and cost will be as follows:—

In the first instance, taking, as examples, cases where the populations may severally be 400 and 1,000, and where there exists a constant supply of water at 20 feet below the surface, recourse may be had to Norton's Abyssinian tube wells. The water is reached by driving tubes down through the ground to the water level. The first tube is pointed and perforated for a few inches with holes varying in size from $\frac{1}{8}$ to $\frac{1}{4}$ inch. Length after length of tubing is driven into the earth at the selected site, and each succeeding length is connected with the last by a screw joint. The perforations at the base are four times as much as is necessary to obtain the full flow of water from the tubes, and they are kept clear by an arrangement adopted by

Messrs. Legrand and Sutcliff, of Bunhill-row, City, for forcing out any sediment or matter that may obstruct a free influx of water. This is effected by suddenly liberating a column of water after it has been raised to a sufficient height above its normal level. The number of tube wells required in a village of 400 would probably be two, and in one of 1000 people, probably five. From figures kindly given to me by the patentees, it would appear that the capital expended in providing the wells and appliances will not exceed 2*s.* per head of the population. Of course, this only refers to the provision of the tubes, the pumps, and the cost of fixing them. There are many instances of small villages and hamlets where one well and pump alone would suffice; but there are others besides those given as illustrations where a number of these wells may be necessary, and which should be united by means of a cast-iron horizontal main or mains, with intervals between the vertical pipes, governed by the nature of the water-bearing seam out of which the water supply is obtained. This distance may vary from 18 to 30 feet. The motive power to work the pumps may vary in kind; water-power may be used when it is close at hand, or gas where it can be readily obtained.

In the second instance (deep sources), the tube wells consist of iron piping fixed in bore-holes, which latter, in fact, form the well, with the piping to serve as the pump barrel and rising main, to raise the water into a service reservoir. These bore-holes will vary in depth according to local features, and in diameter from 5 to 15 inches, according to the quantities of water to be raised. The core of pipes form, as already intimated, a continuous tube from the surface of the bore-hole to the water level below, and are made perfectly flush both inside and out, and must be watertight. They are sunk for a sufficient depth below the standing water-level as to secure an effective discharge. The pump is fixed within the tubing, which forms a cylinder, and it is connected with the engine on the surface by rods properly guided within the tube. Special pains

are taken so to construct and fix the pump, that it may be readily brought to the surface, repaired, and replaced. For the first 15 or 20 feet of the well, a shaft 5 or 6 feet in diameter is necessary, in which to fix the necessary gearing connecting the engine with the pump, and to place the air vessel, &c., regulating the lifted supply to the reservoir. It would appear from figures, supplied me by Messrs. Tilley, of Walbrook, for works which we have now in hand, that the primary outlay varies from £500 in a case where the lift is 100 feet, the supply 40 gallons per minute, the depth of the bore-hole 300 feet and its size 7 inches, to £750 where the lift is upwards of 250 feet, the supply 50 gallons per minute, the depth of the bore-hole over 300 feet, and its size 9 inches.

Besides tubular wells sunk perpendicularly into subterranean water, supplies may not infrequently be obtained by the use of syphons for drawing water out of water-yielding basins, to which there is no natural outlet, by deflected pipes laid over or through the rims of the basins. The extraction of the required supply is effected by dipping the shorter leg of the syphon into the water bed forming a ready-made reservoir, and carrying the larger leg into the village requiring the supply, to act, with proper appliances, as a service main. This automatic mode of raising and delivering water has already been found available for towns as well as villages.

In the cases of Abingdon and Warwick, a syphon arrangement has been found very beneficial. The firm to which I belong, when devising the water supply for the former town (under the immediate supervision of Mr. C. F. Gower), adopted this expedient for raising the necessary supply for a population of over 6000, which we had intended to obtain from a direct adit driven into the bed of coral rag, or calcareous grit, outcropping between Boars Hill and Abingdon, but which we abandoned in favour of a suggestion from Mr. J. Thornhill Harrison, of the Local Government Board, who, at an inquiry held by him, pointed out that the water bed which we were making

preparations to tap might be considered a natural reservoir, from which the required supply could be raised by means of a syphon passing over the bank impounding the water. This object was effected by means of a 9-inch pipe capable of discharging 330 gallons a minute, laid from a reservoir holding 125,000 gallons (which it was found necessary to make within the calcareous grit for storage and ready discharge), the bottom of which was 40 feet higher than the highest part of Abingdon. The shorter leg of the syphon is about 9 feet in length, and reaches very nearly to the bottom of the reservoir. When the water, finding its way out of the calcareous grit into the reservoir, rises above the crown of the syphon (which it generally does during the night), the discharge is by gravitation independently of the syphon; but when it sinks below that level, then the syphon action is called into play. This arrangement has been in existence at Abingdon for four years, without any hitch or difficulty of any kind.

At Warwick, Mr. Edward Pritchard, C.E., adopted a somewhat similar contrivance, whereby he effected a very great saving in the cost of the works. It has now been in operation for more than eight years, and is stated by Mr. Pritchard to work satisfactorily. Syphons, whilst working automatically, involve very little outlay in maintenance, and they would be adopted much more frequently than they are at present, if their special nature and advantages were more fully understood. They have been used with great advantage for the drainage of land and for the lowering of water standing in bogs. I may mention, as an illustration, that in Scotland the Earl of Stair drained by this means a wet marsh near Culhorn House, which had rendered that residence unhealthy. The syphon-pipe (seven inches in diameter) was half a mile long, and it has drawn down the water nine feet.

There is yet another means of obtaining water for villages, which it would be wrong to exclude from the consideration of sanitary authorities, as in some instances, we know from experience already gained, that it can be

resorted to with advantage; I refer to the use of waters from cultivated surfaces, which the Rivers Pollution Commissioners have designated "suspicious" waters. To raise them above suspicion they should be collected and filtered through a bed of natural soil, extending to about one pole (of superficial area) per head of population. By this means the water would be made very superior to that consumed by the majority of householders in rural districts. The preparation of filter-beds of natural soil is simple enough. A plot of land, as porous and free in its subsoil as can be obtained, should be selected and made suitable by special treatment, at such an elevation relatively to the land from which the water would be obtained, and to the village which it is intended to serve, as will receive the off-flow from the former on its surface, and allow it, after it has passed through the filter, to collect in a storage reservoir, and thence to reach the village at a serviceable height. The filter itself should be deeply underdrained, and the water to be filtered through it evenly distributed over its surface. No manure whatever should be applied to it.

The water of under-drainage, when found to contain ingredients of an objectionable character, which the analyses of Professor Way have shown may be the case, can be rendered perfectly unobjectionable by a second filtration through a plot of prepared soil, rigidly preserved from the application of manure.

When we are taught by chemists to believe that the extraordinary purifying powers of aërated soil will render innocuous the discharged sewage of towns in which exists organic nitrogen in considerable amount, we must be satisfied that, by a second passage through natural soil, the water of under-drainage, already once filtered, may be freed from any putrescible ingredients it may have once contained.

This expedient is only suggested where a village being in the neighbourhood of an estate which the owner has underdrained, such owner will allow the water to be diverted

from a natural stream, and filtered before it is supplied for domestic use.

I will close this short paper by drawing the attention of sanitary authorities in rural districts to the "Reservoirs Act, 1877," by which powers are given to the owners of land to supply water "to any sanitary or other local authority" by contract, and to charge their estates with the outlay on works.

WATER SUPPLY.

By EDWARD EASTON, M.Inst.C.E.

THE object of this paper is to put before the Conference, in as concise a form as possible, the considerations which should govern the supply of water for domestic and other purposes, not with the intention of enunciating any new thing, but with the hope of drawing attention to well-recognised principles, which are too often forgotten or neglected.

The three chief points which have to be considered in relation to this subject are :—

1. The source of the water.
2. Its distribution.
3. The conditions under which it is used.

1. With regard to the source, it is evident that, in designing a waterworks, the engineer has to provide that the water shall be adapted to the purposes for which it is intended to be used, both as regards quality and quantity.

The question of quality will depend upon circumstances. It is essential, of course, that in every case the water shall be free from contamination by organic and other impurities ; but the necessity of its being chemically free from other constituents will depend, to some extent, upon the purpose for which it will be used ; for instance, in a manufacturing district, where the water is required for dyeing and such-like purposes, it must be free from certain mineral in-

gredients, whereas for the supply of drinking water and for general purposes, this is a qualification which need not be insisted on.

It is now generally admitted that a soft water is preferable to a hard water, provided that the storage and distribution are properly carried out, and in every case where there is a choice of supplies, that which is soft, or which can be softened by simple means, should be chosen.

The process invented by Professor Clark for softening hard water by the deposition of a portion of the lime, is of a very simple character, and it has been successfully adopted in many cases.

Sources of water proper for use may be classed under two distinct heads. 1st. Those which are afforded by nature in a state absolutely pure and fit for use, such as water drawn from wells and deep-seated springs. 2nd. Those derived from water-courses or gathering grounds which are open to the atmosphere, and which must necessarily be exposed to the risk of contamination from external agencies.

In the case of the former, no works for storage or purification are necessary, the stratum of rock or other material from which the water springs, forming a natural reservoir and filter.

In the second case, it is necessary (*a*) that all direct pollutions shall be prevented from coming into the source; and (*b*) that in almost every instance, efficient means of filtration should be provided. The filtration ought wherever it is found impossible to altogether prevent the chance of contamination, to include the use of some deodorising agent, of which there exist more than one capable of practical application.

As instances may be mentioned the filtration at Wakefield, where, for many years, by the use of Spencer's magnetic carbide of iron, a water very much contaminated was rendered perfectly wholesome; and that at Antwerp, where Professor Bischof's spongy iron is employed with an equally good result.

2. Essential as it is to ensure that the source of supply is proper for the required purposes, it is equally essential that the mode of distribution shall be such as shall prevent its deterioration before being used.

To effect this, it is absolutely necessary that the reservoirs, into which the water is collected for distribution, should be covered, and that the mains and pipes should be perfectly air-tight, and laid at a proper depth below the surface, so as to preserve the water in its original state of purity, and, as much as possible, at the same temperature, during its passage from the source to the consumer.

One great cause of the complaints of the quality of the water in most large towns, is the use of cisterns for storing it in the houses, which it is impossible to employ without the risk of some injurious effect upon the water.

In the Session 1877–8, two Bills were introduced into Parliament, at the instance of the Metropolitan Board of Works, for purchasing the undertakings of the London water companies, and for providing a separate supply of drinking water from the chalk. During the exhaustive examination of the waters supplied by the companies, made by the eminent gentleman who so fitly and ably occupies the chair, Sir Frederick Abel, assisted by Dr. Dupré, Mr. G. H. Ogston, Professor Voelcker, and the late able chemist of the Metropolitan Board, Mr. Keates, it was found that, whilst the water delivered in the mains was in almost every case excellent, the position and condition of the cisterns too frequently rendered it utterly unfit for human consumption. A great number of cistern deposits from all quarters of London were examined by these five gentlemen, with the general result just stated.

It is scarcely credible that the favourite place for fixing the cistern from which the water for drinking and culinary purposes is drawn is immediately over the water-closet or next to the dust-hole, whilst even in the better class of houses, where the cisterns are fixed in the roofs, they are very rarely sufficiently covered, and are open to contamination from soot, dust, inroads of black beetles, and other

abominations. The latest researches of scientific men show that there is no more fruitful source of disease than such a condition of things affords. Although, doubtless, a great deal has been done by the expansion of the system of constant service in London and elsewhere to remedy this frightful evil, the following extract from Sir F. Bolton's report for the month of May shows that there is still much room for improvement. He says:—

"In the monthly and annual reports on the metropolitan water supply, attention is drawn to the necessity which exists for a regular cleansing of cisterns, and also to the fact that contamination of water from gases generated by sewage is of far more frequent occurrence than is generally understood. Waste pipes from cisterns are still to be found which are in direct communication with drains, so that gases may flow back into the cistern and become absorbed by the water. To prevent this an overflow pipe should be brought outside each house and the end left exposed to the air, instead of being carried into a drain, as is often the case. By the adoption of this plan poisonous effluvia and gases from drains would be got rid of, which would otherwise ascend through the pipe, and not only be partly absorbed by water in cisterns, but be mixed with the air in the houses, thereby becoming a cause of disease.

"The attention of consumers has been drawn to the fact that, in houses supplied on the constant system, all danger of drinking stale or contaminated water from cisterns may readily be avoided if the following recommendation is carried into practice, viz., to attach a small draw-off tap to the communication pipe which supplies the cistern from the main in the street, from which water may be drawn at any moment, day or night, direct from the works, thereby taking full advantage of any efforts made by the companies to purify the water to the utmost extent. This water should be used for drinking and cooking, and the contents of cisterns made use of for washing, flushing, baths, and similar purposes."

An abstract from these reports of the water examiner

is printed by the companies at the back of the collectors' rate papers, so that no consumer of water can now be exonerated from the charge of negligence if this abuse is allowed to continue in his house.

3. This consideration naturally leads up to the third division of the subject, viz., the conditions under which water should be used. And first it is essential that a constant supply should be given, without which it is difficult to avoid the deterioration of the water above alluded to.

Not only is it impossible to give an adequate supply by the intermittent system without having storage cisterns in the houses, but there is also a serious danger of contamination by the possible admission of foul air or gas into the mains when the water is turned off. There have been several instances of a water supply being seriously affected from this cause.

But to give constant service it is absolutely necessary also that the supply should be under proper regulations, which shall ensure the prevention of undue consumption and misuse of the water.

Not only are the difficulties of providing the supply greatly increased where waste is allowed to prevail, but the cost to the community is augmented without the slightest corresponding benefit to health.

Nothing is more fallacious than the idea, prevalent among a large section of consumers of water, that the allowing of taps and water-closets to run to waste assists in the flushing and cleansing of the sewers, and therefore conduces to health. These continuous dribblings of water can have no effect whatever in removing any obstructions or accumulations which may exist in the large drains. The only proper and effectual way of removing fœcal matter is so to regulate the use of water that it shall be proportionate to the work it has to do at the moment. Where this is done, by the use of properly constructed water-closets, well-proportioned drains, and by keeping out from the system of sewers the rainfall on the streets and

houses, the ordinary quantity supplied to a town is quite sufficient to perform this service without having recourse to extraordinary means. The question of dealing with the sewage of large communities, which is now so full of difficulty, would be much more easy of solution if these principles were more generally acted upon.

For these reasons, it is not desirable that the supply should be unlimited in quantity; on the contrary, every precaution should be taken to make that quantity commensurate with the real wants of the consumers.

It is quite certain that in almost every town a very large proportion of the water delivered through the mains runs needlessly to waste.

To take an example on the largest scale, the quantity supplied to London, according to Colonel Sir F. Bolton's return for the month of May, amounts to 32 gallons per head per day, about 20 per cent. of which, or say 6 gallons, it is estimated is used for other than domestic purposes, leaving 26 gallons per head as the quantity supposed to be absolutely consumed in the houses. Now it has been ascertained that, on the average, the water really required is not half this quantity; and there is also no doubt that, by taking proper precautions, the amount delivered can be made to approximate very nearly to the actual use.

At Liverpool, by means of careful inspection of fittings, aided by the use of Deacon's meter, a most ingenious arrangement, by which it is easy to localise, and therefore detect, waste, the consumption of water has been reduced from 33 to 22 gallons per head per day, and, within my own experience, the adoption of the same system has, in six or seven instances, produced even more satisfactory results.

The waste of water, whether it arises from leaky joints in the mains and service pipes, or from defective fittings inside the houses, can only be injurious to health from the increased humidity which is thereby imparted to the soil and atmosphere, and which, as is well known, contributes so

much to the spread of infectious diseases and the establishment of epidemics.

At this moment, when we are suffering to a greater extent than usual from the contamination of the Thames, owing partly to the presence of a large quantity of sewage, but also to the abstraction of so large a proportion of the summer flow of the river, it is manifest that the reduction by 33 per cent. of the amount drawn from and discharged into the river would go far to ameliorate the condition of things now complained of.

Among the different proposals which have been made for the introduction of a system which would ensure the prevention of waste, is that of furnishing the supply by meter. This is open to the grave objection that, in order to save money, people would be tempted to go to the other extreme, and to content themselves with an insufficient quantity. To obviate this, some such arrangement as that proposed by the writer to the Select Committee of the House of Commons, over which Mr. Ayrton presided in 1867, might be effectual. The following extract from the evidence given before that Committee will explain the proposal:—

"I think a better method altogether might be devised of supplying the houses in London with water—a better system might be adopted to prevent waste. I should provide a constant service by meter, but under different conditions to any hitherto proposed. I think it could be designed with perfect fairness to the water companies and to the consumers, by making certain arrangements, and the general principle upon which I would propose that that should be done would be this: that there should be a sliding scale adapted to the class of house, and that each house should have a certain amount of water allotted to it. I would take a £100 house, and allot to it 150 gallons per day, and to a £200 house I would allot 300 gallons of water per day, and so on, upwards and downwards, provided that no house should have less than 50 gallons. Let the companies charge the same rate as they do now for that minimum

quantity of water, and if more is consumed or passes through the meter the consumer would have to pay for that additional quantity."

Although at first sight the expense of the meters would appear to be prohibitive, both the consumer and supplier would soon be reconciled to the outlay, the one because he would know what he was paying in proportion to the water he received, and the other because they were only supplying water for which they were paid.

The consideration of the subject of this paper would not be complete without a reference to the important question of the conservancy of our rivers.

It is useless to discuss the method and conditions of supply, if the sources of water are not to be preserved to us, and it is quite certain that, with the immense growth of the population of this kingdom, it will not be long before this preservation becomes a pressing necessity.

In the report presented to Parliament by the Duke of Richmond's Select Committee on Conservancy Boards, in 1877, a very workable scheme was recommended by their Lordships. The Committee say that:—

"In order to secure uniformity and completeness of action, each catchment area should, as a general rule, be placed under a single body of conservators, who should be responsible for maintaining the river, from its source to its outfall, in an efficient state. With regard, however, to tributary streams, the care of these might be entrusted to district committees, acting under the general directions of the conservators; but near the point of junction with the principal stream they should be under the direct management of the conservators of the main channel, who should be a representative body, constituted of residents and owners of property within the whole area of the watershed."

But although the question of improving the water supply by preventing the pollution of the rivers, was incidentally mentioned by their Lordships, it is evident that the main object of the report was the prevention of floods, and not

the conservancy of water for the supply of populations. Now, it may well be said that the one subject is at least as important as the other, and just as the recurrence of a number of wet seasons at that time brought the question of the floods prominently before the Duke of Richmond's Committee, it may safely be asserted that a corresponding succession of dry seasons will compel the serious attention of the Government to the other part of the subject. We need go no further than our metropolis for the proof of this, for if, in addition to the saving of water by the prevention of waste, the flow of the Thames were properly regulated by works in the higher parts of its watershed, there is no reason why the river should not be in a condition which although leaving very much to be desired in the way of improvement, would yet be tolerable, and, according to past experience, absolutely not injurious to health.

When presiding over the Mechanical Section of the meeting of the British Association, at Dublin, in 1878, on which occasion the opportunity was taken to very fully discuss, from a variety of aspects, this question of rivers conservancy, I made a suggestion which, I believe, is worth repeating at the present time. In my address to the Section it was stated :—

"When it is considered that many lives are annually sacrificed, either directly by the action of floods, or by the indirect but no less fatal influence of imperfect drainage,—when it is remembered that a heavy flood, such as that of last year, or that of the summer of 1875, entails a monetary loss of several millions sterling in the three kingdoms ; that during every year a quantity of water flows to waste, representing an available motive-power worth certainly not less than some hundreds of thousands of pounds ; that there is a constant annual expenditure of enormous amount for removing *débris* from navigable channels, the accumulation of which could be mainly if not entirely prevented ; that the supply of food to our rapidly growing population, dependent as it is at present upon sources outside the country, would be enormously increased by an adequate protection of the

fisheries; that the same supply would be further greatly increased by the extra production of the land, when increased facilities for drainage are afforded; that, above all, the problem of our national water supply, to which public attention has of late been drawn by H.R.H. the Prince of Wales, requires for its solution investigations of the widest possible nature,—I believe it will be allowed that the question, as a whole, of the management of rivers is of sufficient importance to make it worthy of being dealt with by new laws to be framed in its exclusive behalf.

"A new department should be created—one not only endowed with powers analogous to those of the Local Government Board, but charged with the duty of collecting and digesting for use all the facts and knowledge necessary for a due comprehension and satisfactory dealing with every river-basin or watershed area in the United Kingdom—a department which should be presided over, if not by a Cabinet Minister, at all events by a member of the Government who can be appealed to in Parliament."

It is earnestly to be hoped that no further time will be lost in passing an Act to deal with this subject, and that no considerations of a party or private nature will be allowed to prevent a scheme of so important and imperial a character being made as complete and comprehensive as possible.

In conclusion, as I commenced by saying, I have not attempted to say anything new; indeed the subject has already been in the hands of far abler exponents than myself; especially would I refer to Dr. Frankland's very able and comprehensive Sixth Report of the Rivers Pollution Commission, the careful study of which is recommended to everybody who wishes to master the details of the question.

SOURCES OF WATER SUPPLY.

By JAMES MANSERGH, M.Inst.C.E., and M.E., F.G.S., F.M.S.

IT used to be a popular belief that if a well were sunk at any place to a sufficient depth into the ground, there would be reached an inexhaustible reservoir of water, a store that had been filled in some mysterious manner at the creation of the world, and would suffice for the use of man for all time.

It is now well known that all supplies of water, whether found upon the surface, or below it, in underground depths, are derived from the rain which falls upon the earth, and that it depends upon the geological character of the surface receiving the rain whether it shall run off in the form of streams and rivers, or soak in and be apparently lost.

Rain is produced from the evaporation of invisible aqueous vapour, principally from the ocean, by means of solar heat, its condensation, primarily into the shape of clouds, and subsequently into the form of drops, which fall to the ground.

The sea is thus a storage reservoir of boundless capacity, and the sun is the great prime mover which pumps the water up from this reservoir, distributes it over the land, and lifts it to the hills, where it may be impounded in natural or artificial lakes, and thence delivered by gravitation to the plains below.

After being discharged on the earth in the shape of rain or snow, a part of the water is re-evaporated, but the greater part begins at once to travel downwards, either over the surface, in the form of rills and streams, and so on to the ocean whence it came, or through the surface, if this is permeable, into fissured or porous rocks below.

A portion of this latter water passing into the ground at *high* levels, has several courses open to it. It may appear

in the shape of springs at lower levels, or rise in the beds of rivers, or run out through fissures on to the sea beach, or sink below sea level, whence it will be recoverable only by artificial means.

Nature has in this way provided water from one great source in ample quantity for the use of man, but works of varying character, under differing local circumstances, must be constructed to store and utilise it.

Altitude and the geological structure of a district are the two principal factors which determine what the source of water supply must be in such district. The two great classes into which sources may be divided are (*a*) above-ground and (*b*) underground sources.

The former (*a*) has several subdivisions, which may be described as follows :—

1. Water may be taken from the heads of streams by laying pipes right up to the springs, to convey it away for supply without any intermediate storage, as in the case of Lancaster. This is a source which in some sense belongs to the two classes, for the water is taken just as it ceases to be underground water, and is being delivered on to the surface above ground.

2. It may be obtained from a natural lake like Loch Katrine, as in the case of Glasgow.

3. It may be collected from a high-lying watershed area, by impounding a number of small streams in artificially constructed reservoirs, as is done for the supply of Manchester.

4. It may be taken from a large river flowing past a town, as is done in the case of the Thames and Lea for the supply of London.

The second class (*b*) is not divisible in the same way as (*a*), but may be taken as embracing supplies of water obtained from many varieties of geological stratification, such as chalk, oolites, coal measures, millstone grit, magnesian limestone, Bagshot sands, and many others.

All water, when discharged upon the earth as snow or rain, is practically pure, but its character is very soon

changed by the material it comes in contact with on the surface, or in passing through underground fissures and channels. Take, for example, the rain which falls upon the chalk downs of Sussex or any other similar geological area. It sinks at once beneath the smooth and rounded surface, and percolates through innumerable minute cracks or larger fissures, dissolving away the chalk which it touches, and finally issues naturally in springs along the coast, or is pumped out artificially, a water which contains from fifteen to twenty-five grains per gallon of carbonate of lime.

Such an alteration in character depends of course upon the nature of the rocks which the water traverses, some rocks being easily soluble, others not.

The taking up of lime or magnesia in this way has the effect of rendering the water "hard," that is, increasing its soap-destroying properties. For many manufacturing processes this is a most undesirable quality, and we therefore find that many of the important industries of the country are located in districts where soft water is easily procurable.

The following are the formations which yield as a rule soft water:—Igneous, metamorphic, cambrian, silurian (non-calcareous), Devonian (non-calcareous), millstone grit, coal measures (non-calcareous), lower greensand, London and Oxford clay, Bagshot sands, non-calcareous gravels.

On the other hand the following geological formations almost invariably yield hard water:—Silurian (calcareous), Devonian (calcareous), mountain limestone, coal measures (calcareous), new red sandstone, conglomerate sandstone, lias, oolites, upper greensand, chalk.

The manufacturing towns of Lancashire and Yorkshire obtain their supplies from sources which, even if the water had passed underground, would leave it comparatively soft, but this quality is fully secured by the character of the works, which consist of large reservoirs impounding the water which has principally run merely over the surface. For dietetic purposes, the quality of hardnesss if not excessive, that is if it does not exceed twelve grains on

Dr. Clark's scale (equivalent to twelve grains of bi-carbonate of lime per gallon), is not considered objectionable on physiological grounds. For ordinary domestic purposes, and especially for personal washing and cleaning generally, soft water is infinitely preferable to hard, both in respect of comfort, efficiency, and economy.

Taking into account all the purposes for which water is used, it can hardly be questioned that a pure soft water supply is on the whole preferable to a pure hard water supply. The term "pure" is here used to imply the absence from the water of organic impurities as distinguished from the dissolved inorganic matters which have before been referred to. Except as producing hardness, the inorganic matters usually found in water are practically harmless; but organic pollutions may be of the most disgusting and dangerous character, those for instance which are the result of contamination with town sewage or cesspool manure.

It is to avoid the risk of such pollution that many towns have in great measure been led to seek their sources of supply on elevated moorlands, above the level at which arable cultivation is carried on, and where it follows that there are no towns or villages, and the scattered population is very sparse. In this country the plough is rarely seen above the 800 ft. contour, and as it will not pay to cart manure to such an elevation, these high lands are merely used for the pasturage of sheep and the rearing of grouse.

Water obtained from such sources is practically, therefore, in the condition in which it falls from the clouds as snow or rain. The only impurity it may contain is a little organic matter derived from passing over the peaty soil, which often occurs on high moorlands, especially where the summits are broad and comparatively flat. This contact with peat, and with growing heather, gives a stain to the water to such an extent that, when seen in deep reservoirs, it looks like dark coffee.

As seen in an ordinary white glass bottle or tumbler, the tinge is rarely deeper than a very faint straw colour.

There is nothing harmful in this colouring matter, because it is of purely vegetable origin, and to some extent it may be removed by storage in open reservoirs, or running in open channels exposed to the air.

Many towns are so located in this country that it is practically impossible that they should obtain pure water supplies from elevated water-sheds, on account of the enormous expense that would be entailed in the construction of the necessary works. Such places must be content to be supplied from rivers in their immediate neighbourhoods, and which, having run their courses through many miles of highly manured lands and past thickly populated towns and villages, contain water which has necessarily become polluted by the washings from the lands and the sewage from the towns. Such sources as these would be inadmissible, but for the great rehabilitating process which nature silently carries on in a river, and to which chemists apply the term "oxidation." In this wonderful process, the polluting organic matters which the water contains are converted by the agency of oxygen into harmless inorganic salts, and the water again becomes fit for the use of man.

This statement must, however, not be made without some reservation and explanation, because chemists of the very highest standing are not agreed as to the extent to which rehabilitation of the water is carried. This has, in fact, become quite a burning question, and the battle has been fought long and frequently over the water which is taken from the Thames, and delivered for consumption by the inhabitants of London.

The difference of opinion is now narrowed down into a small compass, and to outsiders it would appear that there is a chance, sooner or later, an agreement may be come to between the authorities.

As representatives of the two sides may be named Dr. Frankland and Dr. Meymott Tidy. Dr. Frankland admits that oxidation is effective in burning up, or converting into a harmless condition, even such vile contaminations as

human sewage, if this is in a normal or healthy condition; but he contends that the virulent zymotic diseases are propagated by organised germs contained in the sewage which are indestructible, and which may travel scores of miles in a running stream without being deprived of their fatal potency.

Dr. Tidy contends, on the other hand, that there is no evidence of the existence of these animated germs, and affirms that a run of a few miles in a river fully oxygenated, and in which the pure water bears a sufficiently high ratio to the polluting matter, will suffice to render such water again fit for human consumption.

Dr. Frankland's theory is naturally a disquieting one; and his opponents certainly have facts in their favour, for London is undoubtedly one of the healthiest cities in the world, and its inhabitants have never been known to suffer from disease induced in the way suggested.

The "germ" theory is, however, making steady advances under the investigations and researches of competent men, and it is to be hoped and expected that if the historic germ is at last discovered, and exhibited to the incredulous gaze of Dr. Meymott Tidy, he, or some of his *confrères*, may speedily discover a method of scotching it before it has time to do any mischief.

It may now be convenient to describe shortly a few typical examples of the utilisation of the different sources of supply which have been thus generally referred to.

I. Take, first, such a case as that of Lancaster, whose works supply a population of between 30,000 and 40,000. The town is situated on the river Lune, about seven miles above its junction with Morecambe Bay, and is built upon a site which, rising from the river, varies in elevation from 15 to 200 feet above Ordnance datum, or mean tide level. The water is obtained from the high moorlands of Wyresdale, at a distance of eight or ten miles from the town, in a south-easterly direction. These fells, as they are locally called, constitute the extreme north-easterly portion of the watershed of the river Wyre, a small river which also falls

into Morecambe Bay near the town of Fleetwood. That portion of the fells which is secured by Act of Parliament as a source of water supply for Lancaster, has an area of 2700 acres, and an altitude varying from 850 to 1800 feet above the sea.

The geological formation of the gathering ground is millstone grit, covered with scant herbage suitable for sheep pasturage, and heather. Interstratified with the beds of permeable grit stone there are layers of impervious shale which, at various levels, throw out the water percolating downwards from the surface, in the shape of springs, and a number of these springs have been intercepted by small pipes communicating with mains laid along the hill-side, and leading their combined waters to the south-west corner of the reserved area.

One of these mains forms part of the original works constructed under the superintendence of Sir Robert Rawlinson, C.E., C.B., in the year 1852; the other, which runs (broadly speaking) parallel to the first, but about 200 feet lower down the hill-side, was laid six years ago, as part of an extension carried out by the writer.

The water derived from these is of necessity of the purest possible character, for the rain which feeds the springs falls upon the clean open moorland, and sinks at once into the millstone grit rock, in which it finds nothing to dissolve and cause hardness, and nothing to organically pollute.

The water issues from the springs in a bright sparkling condition, at a constant temperature of about 45° F.; it contains only one grain in 15,500 of solid matter, and its hardness is under 1° on Clark's scale.

This may be fairly regarded as an ideally perfect source of supply, and it has been an inestimable boon to the inhabitants, especially as it replaced water obtained from shallow wells in the town, polluted in the vilest possible manner by percolation from numberless foul and reeking privy pits and middens.

Between the fells and the service reservoir, which is

situated on the town moor 240 feet above Ordnance datum, the country is intersected by several valleys, across which the water is conveyed in iron pipes.

At two intermediate points the pressure is broken by small covered tanks, and the water is never exposed to the open air from the time it sinks into the ground as rain or snow, and is drawn from the consumers' taps in the town.

Perhaps it may be as well to explain here that, when water is obtained from elevated watershed areas of this character, Parliament almost invariably insists upon "compensation" being made to the river for such abstraction. This compensation is secured by the construction of reservoirs somewhere upon the main river or its tributaries, in which water is stored in time of flood, and given out in a constant stream in times of dry weather, the assumption being that floods are utterly useless, if not damaging, to riparian owners and millowners, whilst it is of advantage to every interest to have the dry weather flow increased in volume.

Thus, in the Lancaster case, whilst the Corporation have the right to take 2,000,000 gallons a day from the springs for the use of the town, they were put under the obligation to construct upon the river Wyre a reservoir capable of holding 185,000,000 of gallons, from which the millowners have the right to draw water according to their needs during the summer months. By means of such works, all the parties concerned are very greatly benefited.

II. The second type of utilisation of sources which may be referred to, is that which is exemplified on so magnificent a scale in the works supplying Glasgow, and constructed from the designs and under the superintendence of Mr. John Frederick Bateman, C.E.

In this case, advantage is taken of three natural lakes, viz., Loch Katrine, Loch Venachar, and Loch Drunkie. The watershed area draining into these lakes is 45,800 acres in extent, and consists of unpolluted sparsely populated moorlands, the geological formation being of silurian age.

Loch Katrine has a water surface of 3000 acres, Loch

Venachar 900 acres, and Loch Drunkie 150 acres. They are all of course supplied by the rain which falls upon the 45,800 acres, and as a considerable proportion of this area is of a peaty character, the streams which run down the mountain sides are frequently as dark as London porter. By the deposit of the heavier parts of the peaty matter, and the bleaching action of the air, the water is drawn from Loch Katrine with only a faint tinge of colour.

The two smaller lakes are utilised as compensation reservoirs, the artificial storage necessary being obtained by raising the original normal level of Loch Venachar 5 feet 8 inches with power to draw it down 6 feet, and by raising Loch Drunkie 20 feet, the raising in both cases being done by masonry dams across the outlet valleys, furnished with draw-off sluices.

The storage for the supply of Glasgow is obtained by works which raised the normal level of Loch Katrine 4 feet and admit of drawing down 3 feet. Its capacity is, therefore, 3000 acres of area, by 7 feet in depth, equivalent to nearly 1000 million cubic feet, and competent to furnish 50 million gallons a day during a four months' drought.

The water surface in Loch Katrine is 360 feet above mean tide level at Glasgow. The conduit conveying the water to the city commences on the south side of the lake, about three miles from its western extremity, and runs generally in a southerly or south-westerly direction. At 26 miles from the Loch it discharges into an artificial reservoir of 70 acres in extent, and holding 500 million gallons near Mugdock Castle, the top water of this reservoir being 311 feet above mean tide at Glasgow. Two lines of three feet cast-iron pipes, one seven miles long and the other eight miles, convey the water to the city.

For thirteen miles out of the twenty-six between Loch Katrine and Mugdock, the conduit is formed by tunnelling through very hard rock, such as whinstone, gneiss, and mica slate; the tunnels being seventy in number, nine miles of the remaining length is "cut and cover" work, and the rest consists of cast-iron or wrought-iron pipes across valleys.

The advantage of such a source of supply as Glasgow's is the facility and small cost with which the storage capacity necessary to furnish the requisite daily quantity for consumption and compensation is obtained.

In Loch Katrine, the narrow outlet from the lake had only to be dammed up four feet, requiring artificial works of the simplest character, entailing no risk or contingency in their execution. Having a flat area 3000 acres in extent to begin with, a simple plank one foot high would have sufficed to impound 816,000,000 gallons. The desirability of securing such a reservoir site as this can only be fully appreciated by those who have had the responsibility and anxiety of forming large storage reservoirs, by the construction of high embankments across valleys. The relative amounts of labour and outlay in such reservoirs, and in cases like Loch Katrine, will be better realised in considering the next type.

III. The third type of works for the utilisation of mountain watershed sources of supply is well exemplified in the Longdendale valley, where a number of reservoirs have, during the last thirty years, been constructed for the supply of Manchester. Here, instead of having a level plain 3000 acres in extent, as in Loch Katrine, upon which to commence as the bottom of a reservoir, was a valley with a fall along the bed of its main stream—the Etherow—of between 60 ft. and 70 ft. in a mile. Across this valley five embankments have been constructed of earthwork, one above another, forming five lakes with a combined water surface area of 462 acres. Beginning from the lowest part of the valley, the following is a list of the reservoirs, viz.:—

	Height of Bank. Feet.	Water area. Acres.	Capacity. Gallons.
Bottoms	66	50	407,000,000
Vale House	55	63	343,000,000
Rhodes Wood	75	54	500,000,000
Torside	100	160	1,474,000,000
Woodhead	80	135	1,181,000,000
Total	376	462	3,905,000,000

These embankments, which cost something like £100,000 apiece, have an aggregate height if placed one above another of 376 ft., and the quantity of water they impound is 3905 million gallons. The raising of the water surface of Loch Katrine 5 ft. would create the same amount of storage. The watershed area supplying these reservoirs is 9300 acres, and the geological formation is millstone grit. The gathering ground is a portion of the western slope of the "backbone" of England, otherwise the Pennine range, upon which, over its whole length on both sides, many similar works are located for the supply of the manufacturing towns of Lancashire and Yorkshire. The rocks in this district are very much fissured and broken, and the rain falling upon the higher grounds percolates below the surface and reappears as springs at lower levels. Advantage is taken of this by conducting the spring water along special channels into the Rhodes Wood reservoir, from which the supply is taken by a conduit to the town.

Although the quantity of water yielded by the whole gathering ground is that due solely to its area and the rainfall upon it, the fact of there being these springs renders it more valuable, because it implies that water which would have run off a district composed of harder and less pervious rocks, is here absorbed into the mass, which thus acts as so much storage or reservoir space. The effect of this is to increase the dry weather flow of the streams, and to furnish water which is clear, cool, and colourless. The average annual rainfall upon the 19,300 acres is about 50 in., and the works utilising this area are competent to provide 38,000,000 gallons per day, of which 13,500,000 have to be delivered into the stream below the reservoirs as compensation water. Besides the five reservoirs above named, there are other large impounding and service reservoirs at Godley, Denton, Gorton, and Prestwich. In the construction of these works enormous difficulties have been encountered, and at Woodhead, the highest reservoir of the series, the embankment, as at first made, was not watertight, so that a second trench had to be put down in which

to build the puddle wall, and so much were the measures disturbed and distorted, that on the south side of the valley this trench had to be excavated to 167 ft. below the surface of the ground, before sound and tight material was reached upon which the wall could be based.

The three types of works thus described may fairly be said to exhaust the methods of obtaining water from sources situated on elevated mountain gathering grounds. They are good examples of the gravitation system of supply, by which water is delivered at high pressure above the highest parts of the towns without any artificial pumping being required, the sun having done this work in the process of evaporation.

IV. We will now consider a case where the town to be supplied is at such a distance from high ground that the cost of bringing it through conduits or pipes by gravitation is prohibitive.

Take a town built along the banks of a river anywhere above the range of the tide. If this river flows through an agricultural district, and is thus not polluted by manufacturing refuse, and not seriously by either manure or sewage, it may be adopted as the source of supply. In this case the water will have to be lifted by artificial means to such an elevation as is necessary to command the whole town.

The water will also require filtration, because in running its course through the country the river receives the washing from the land ; and in times of heavy rain, at all events, the water will be discoloured and turbid through the presence of suspended matters.

The works for the supply of London are in great part of this character, the rivers Thames and Lea being the two sources.

Three hundred years ago, water was obtained from the Thames at London Bridge, and pumped by means of a water-wheel under one of the arches through wooden pipes into the streets and houses in the neighbourhood. These works were continued in operation for 200 years, and were

supplemented early in the 17th century by other pumping stations, taking water from the Thames at Charing Cross, Battersea, Vauxhall, and Hammersmith, all within the range of tidal influence.

In 1848, the Lambeth Water Company obtained powers to go into the non-tidal portion of the river above Teddington Lock, and by the year 1851 they were in a position to deliver water by means of a large steam-pumping establishment erected at Seething Wells.

In 1852, an Act was passed which made it unlawful for any company to supply water taken from the river below Teddington Lock, or from any of its tributaries within the tidal range. This led, finally, to all the companies drawing water from the Thames so rearranging their works as to have their intakes above Moulsey Lock, in order to be above the junction of the river Mole, which frequently brings down very dirty water.

Owing to the changes in the points of intake, the works of the London companies are divided into portions at great distances apart. Thus the Southwark and Vauxhall Company have at Battersea the reservoirs, filter beds, and pumping machinery constructed for the purpose of taking in water from the river at that point. They are well known to all Londoners by reason of the tall stand-pipes which form a prominent object in the view from the trains running out of Victoria Station.

These works are of so costly and extensive a character, that they could not be abandoned when the source of supply was changed to Hampton, twenty-one miles higher up the river, but the water abstracted there is pumped down to them through large cast-iron mains, to be filtered and distributed by the original machinery and mains.

In the case of the Lambeth Company, the water is taken from the Thames at Moulsey, and sent down to Surbiton, which is the site of the filtering and pumping station, through a large brick conduit, by gravitation.

From these circumstances, none of the London works are good examples of the type now under consideration ;

but the following description will explain the nature of the works required for the utilisation of such a source as the Thames above London.

First of all, then, provisions must be made to meet the difficulty of the water arriving at the intake in times of flood in a state of great turbidity or muddiness. This is met by the provision of large reservoirs, which are always kept full so long as the water is coming down in good condition, and the inlets into them from the river are closed, and they themselves are drawn upon when the water of the river is turbid.

These reservoirs used to be of smaller capacity than at present, and were worked as subsidence tanks, that is to say, the water (which might be somewhat turbid) was let in at one end and drawn off only from the surface at the other, the suspended matters causing the turbidity subsiding to the bottom during the water's slow passage through the tanks.

In London, since the works of the several companies have come under the official supervision of Sir Francis Bolton, very large sums of money have been spent in increasing the efficiency of these subsiding tanks, by greatly augmenting their capacity, and practically changing their character into that of storage reservoirs.

In some of the works, these reservoirs are constructed at such a level that the water from the river flows into them by gravitation; in others they are elevated above the ground, and the water is pumped into them. In either case it is next delivered on to the filter-beds, the construction of which is shown very clearly in the most interesting pavilion erected in the Health Exhibition by the water companies. These filters consist of reservoirs or tanks, made either by excavation in the ground, or partial excavation and partial embanking, as circumstances may dictate, having their sides sloped and pitched, or of vertical brick, stone, or concrete walls. The bottom is formed in many different ways, but it is always furnished with a number of open-jointed or perforated pipes or

drains into which the water can pass, and by which it may be conveyed away to a pure-water chamber or pump-well. Upon this floor the filtering material is placed, and consists of clean stones, flints, gravel, shells, and sand, arranged with the largest sized material at the bottom and the finest at the top.

Probably the oldest style of filter shown in the Exhibition is that designed by the late James Simpson, C.E., for the Chelsea Company, and it contains all the materials above mentioned, and has a total depth of 6 ft. 3 in.

As, however, the really operative and effective portion of the filter is the sand, modern practice is tending in the direction of diminishing the depth of filtering material, and of omitting entirely several of the strata originally used. For instance, the New River Company's engineer exhibits a filter composed solely of 2 ft. of sand, resting upon 6 in. of gravel, the total depth being only 2 ft. 6 in. In working the filters, the water is brought from the storage or subsiding reservoir on to the top of the sand, and stands from 2 to 3 ft. above its surface. It then percolates downwards through the filtering material into the drains below, and is run away to be pumped for distribution.

The speed of filtration may be adjusted by the head under which the filter is worked, that is, the difference in level betwixt top water and the draw-off. In some cases this is only 2 or 3 in. The speed at which the water should pass vertically downwards through the sand used to be stated as 6 in. per hour, which gave 675 gallons per square yard per day of 24 hours, but the London companies are now not filtering more than 450 to to 500 gallons, or from 4 to 4½ in. per hour.

The matter which is arrested by the filters consists principally of finely divided mineral matter washed from the surface of the land, of some vegetable and a trace of animal matter. These impurities are caught almost entirely in the top half-inch of the sand, which in course of time they choke and render impervious. The filter is then

put out of use; the water is drawn off, and a skimming of the fouled sand is carefully removed and washed in apparatus which separates the light muddy matter and leaves the clean sand, which is again put upon the filter. Of course, the washing process involves some loss of sand, and periodically additions have to be made of new material. After filtration, the water is in a fit condition to be pumped and distributed to the consumers.

Thus far we have been dealing with "above ground" sources of supply, obtained either by gravitation or by artificial pumping, under the four heads numbered—(1) being springs at high elevation, without storage; (2) being surface water from moorlands drawn from natural lakes; (3) being surface water from similar watersheds, impounded in artificial reservoirs; (4) being river waters filtered, and artificially pumped for supply.

There are in this country a few examples of hybrid schemes, that is, where water from comparatively low agricultural land is impounded in large reservoirs, and where it has to be subsequently filtered and pumped for distribution in the district. There may also be cases where water collected at a sufficient elevation to supply a town by gravitation has to be filtered before delivery.

We now come to the underground sources of supply, and one or two examples will suffice to explain how these are made available. We need not go far from home to learn all about one of the most important of these underground sources, for it lies under our feet in the chalk forming one great feature of the London basin.

London is actually built upon the tertiary deposits, which consist of Bagshot sands, London clay, and the sands and mottled clays of the lower strata; but underlying all these is a mass of chalk having the southern edge of its outcrop on the north of London about Hatfield, and the northern edge near Royston, and its southern outcrop extending from Croydon to Mersthan. On the west the chalk reaches as far as Devizes, and on the north-east to near the coast of Norfolk and Suffolk. Portions of this

vast area are no doubt covered by impermeable drifts of varying character, but there is still a very large tract of country upon which the rain which falls sinks below the surface, and goes to charge the great underground chalk reservoir below.

Possibly, the term "reservoir," though a common one, is a little misleading as applied to the chalk, because for water supply purposes, a large proportion of that which percolates into its mass is not recoverable by ordinary means. It is the water which circulates through the cracks and fissures which is really available, and not that which is held in the minute capillaries of the mass. Some chalk will contain 20 per cent. of its own bulk of water, and yet will not yield a drop of this under ordinary conditions.

Of the water which thus sinks into the chalk, a large portion finds its way out again into the bed of the river, another portion appears in the shape of large springs, such as those at Carshalton and Croydon, which go to form the river Wandle, by flowing over the edge of the impervious tertiaries

Very rarely are there any streams where the chalk itself comes to the surface, but after heavy and continuous rains, streams do appear and flow for a time, and these are known as "bournes." As the chalk is 500 or 600 ft. thick, a very large quantity of water is, however, left in it below the level of any of these natural outlets, and this water can be obtained in London by sinking wells through the overlying impervious beds of London clay, and allowing the water to rise, as in an Artesian well.

There are a large number of wells in the London basin, and one of the metropolitan water companies, the Kent, obtains its supply exclusively from such wells. The ordinary practice is to sink a well from 5 ft. in diameter upwards, and line the same either with brickwork or cast-iron cylinders down to the chalk. This will pass through superficial gravels, blue clay, bands of sand, mottled clay, &c., and sometimes on the top of the chalk a band of flints will be found. Below the bottom of the well a boring is

then made from 4 inches up to 15 or 18 inches in diameter, and lined with iron whilst in soft or much broken chalk, and left unlined where the material is more compact.

In those parts of London which are not elevated many feet above the level of the river, the water rises to very near the surface of the ground, and in some cases overflows; but wherever large quantities are required, resort must be had to artificial pumping so as to lower the level of the water in the well, and thus open out a larger cone of exhaustion in the chalk. Favourably situated chalk-wells yield as much as 2,000,000 to 3,000,000 gallons a day.

In many cases wells and mere borings have been put down right through the chalk to the upper greensand or gault below, and have yielded only a very small quantity of water. This arises from the fact before referred to, that the water circulates freely only in the cracks and fissures, and if some of these are not cut into by the boring, little water is obtained. The most certain way, therefore, of ensuring a supply from the chalk, is by sinking a well down to below the permanent level of saturation, and then driving headings or adits in various directions, for the purpose of reaching some of these fissures. Many of the towns along the south coast of England are supplied by works of this character. It has been found that where the chalk of the South Downs has been undisturbed and is unfaulted, there are large vertical fissures which run, broadly speaking, from north to south, that is, at right angles to the coast. Along these fissures the water travels freely, and has its outlet at the base of the cliffs on the coast, and may be seen running down the beach in many places into the sea.

Parallel to the coast, the water is found to lie with its surface nearly horizontal, because of these permanent outlets; but on lines at right angles to the coast, the surface of the water rises rapidly inland, on a nearly uniform slope, so so much so that, at six miles from the coast, it stands more than 200 feet above mean tide level. Advantage has been taken of these conditions at Brighton, and other places

similarly situated, to sink wells and drive headings parallel to the coast, at about the level of low water.

At Brighton there are two such stations, one at Lewes-road on the east, and another at Godstone Bottom on the west. These wells are both about a mile and a quarter from the sea, and headings are driven to a total length east and west, from Lewes-road, of 2400 feet; and at Godstone Bottom, of 1300 feet. In the first case, fissures are met with about every 30 feet, but as a rule these are small, and do not yield more than 100 to 150 gallons a minute. In the latter they are further apart, but some of them yield 700 or 800 gallons a minute, or over a million gallons a day. This water, being intercepted by the headings, is led to the respective wells, where, by means of suitable steam machinery, it is pumped up to the several service reservoirs supplying the different zones of the town.

The water so obtained requires no filtration. It is bright and sparkling, but of necessity hard, and although not objectionable for dietetic use, is not well fitted for cooking or cleansing purposes, and would be utterly unsuitable for the manufacturing processes of Lancashire and Yorkshire, though thoroughly well adapted for paper making.

In addition to the chalk, good supplies of underground water are obtained in the South of England from the Hastings sands and the oolites, and in the north from the new red sandstone, magnesian limestone, and other formations; but in all cases the works required for the utilisation of these sources are very similar, consisting of wells, borings, and adits, with competent pumping machinery.

Comparing very generally "above-ground" supplies by gravitation with "under-ground" supplies involving pumping, there are advantages and disadvantages on both sides, which may shortly be summarised as follows:—

"Above-ground" Gravitation Sources.

Advantages.	Disadvantages.
1. No pumping.	1. Distance from place to be supplied.
2. No filtration.	2. Peaty stain.
3. Softness.	3. Costly and somewhat risky impounding reservoirs.
4. Low charges for maintenance.	4. Large works involved to provide water "compensation."

"Under-ground" Pumping Sources.

Advantages.	Disadvantages.
1. Proximity of source to place to be supplied.	1. Annual charges for pumping.
2. Low first cost.	2. Hardness (generally).
3. Few structural contingencies attending works.	
4. No filtration.	
5. No compensation for abstraction of water.	

DISCUSSION.

Sir Robert Rawlinson, C.B., said the suggestion of Mr. Easton with regard to supply by meter for large consumers and trade purposes was one of great interest, not only to the public of London, but to the outside public generally. The whole point would turn on the possibility of supplying a reliable meter cheaply, when he did not think a system of supplying water by meter would be objectionable. The great abuse at present in the supply of water for domestic use, under high pressure, was the intolerable waste which took place, which made it almost impracticable to keep up a supply of water at a moderate cost. In the metropolis the supply was equivalent to about 32 gallons per head of men, women, and children, and it needed no great reasoning powers to see that there must be in that vast supply a great deal of waste, for no such quantity could be used legitimately. Some of it the tenant

was not liable for, being lost by leaks in the mains; some was lost by leaks in the service pipes, but a great deal was lost by having fittings out of order, and services deliberately left open to flow during the night. That tended to prevent a constant service, and, therefore, he should not object personally to seeing water sold by meter. In another paper the word "pure" had been applied to certain gathering grounds, such as the great moorlands of the country, which were supposed to give a pure supply of water, but this was a great mistake. There was no pure source of supply, as when water came in contact with the earth, even on the mountains of Scotland, which gave a very soft water, they were covered with vegetation up to their summits, and were inhabited by different animals and birds, and whatever the value of that water might be as soft water—and it had its value—for domestic purposes it was very dangerous, especially to strangers. People coming from England to the highlands of Scotland were almost certain for the first few weeks, if not longer, to be attacked by diarrhœa. He spoke practically, because he and his family had suffered from it; when he was down at Ballater, some time ago, he spoke to the commanding officer at the station where the military were brought down when the Queen was in Scotland, and he learnt that invariably when the soldiers were brought there one-half of them suffered from the softness of the water, and something it contained, which was washed from the mountains. The medical officer also told him that strangers were frequently obliged to leave the district on account of the effect that the water had upon them. A great deal was said against water taken from the Thames, and he was not going to advocate impure water or hard water, but he had had to study the question as a practical engineer, in some respects philosophically, and as it concerned his own health. He had lived three times in districts supplied with what was termed pure soft water, and his experience there had made him very glad to get back again to so-stigmatised polluted Thames water. Even for washing, for which soft water

was so much prized, he had more pleasure in washing in London water than he had in the lake waters, for if you used soap—and you could not clean yourself thoroughly without it—you had the greatest possible difficulty in keeping sponges and things about the toilet table clean, because the soft water would not easily take the soap out. You might get water from tube sinkings, and deep wells, but you did not then get pure water. The late Dr. Angus Smith—and no one had paid more attention to the qualities and character of water than he had—said that if you gave him the analysis he could tell the stratification the water came from ; and, on the other hand, if you gave him the stratification he could predict the character of the water which would come from it. And that must be so because water as it fell from the clouds was soft water, the purest water in nature, and it was a powerful solvent. It dissolved and combined with any of the salts that it came in contact with. He often regretted that persons travelling in Africa, or in any country not previously traversed by civilised man, that they did not describe the appearance of the rivers and lakes more particularly, and mention whether the water was brown, or what character it had. If you saw a river running bright and sparkling, you might put it down as coming from a limestone source ; if it were running bright and brown, it came from a primitive source, slate or granite. Of course when rivers were in flood and turbid, you could not predict anything about them. Water to be used for domestic purposes required special care in treatment and in storage. When a river is the source, the water must be filtered : as from the Thames, the Ganges, and the Nile. Deep well water, from chalk, new red sandstone, or from the oolites, must be stored in covered reservoirs ; as if exposed in open reservoirs to sunshine and air, such waters become polluted to a worse degree than river water filtered.

Mr. Edwin Chadwick, C.B., said sanitary science had still to be applied to the instruction of engineering science in this matter of water supply. Originally, he did not

object to soft water supplies, for in the then state of knowledge it was stated that the main infusion to which they were liable was from the peat, and a certain amount of tannin, which was not thought particularly injurious; but subsequent experience had shown there were further objections, and he did not think Sir Robert Rawlinson had stated them sufficiently broadly. Very soft waters, the surface washings of moorlands, were in use in Manchester, in Glasgow, and also in Dublin. He had received particular results of the soft water in Glasgow for nearly three months, and found the infusion of peat rendered it unfit to drink, as it produced dyspepsia. In Manchester, the peat-tainted water had the same effect, and he believed the same occurred in Dublin. In Manchester, it not only produced dyspepsia, but had such an action on lead piping as to lead to a large amount of lead poisoning. There was no doubt that in those places the water was not fit to drink during a certain portion of the year. He found that in Glasgow it was customary at some hotels to use glasses coloured, so as to conceal the colour of the water which was supplied. In the face of such experience, what was to be said of the proposal to bring to London 200 gallons per head of peat-tainted water—which for two or three months in the year was not fit to drink? At that time, Clark's process had not got farther than the reduction of hard water to 8°, but now it could be reduced to 4 or 3½, and in those localities, such as Canterbury, where first hard spring water had been thus softened, it produced the finest water possible, which delighted the consumers not only for drinking, but for all domestic purposes. He looked forward to the time when the supply of water would be reduced as it was in Manchester, Sheffield, and other places, to some 17 gallons per head per day. It might certainly be reduced by half, and if that were accomplished, it would reduce the intakes very materially, and also the establishments of the water companies, and this would be further aided by the chalk sources being utilised. It should be remembered that the Board of Health, some years ago, directed an

examination of the spring supplies near the metropolis, and it was found that some 40 million gallons of water could then be drawn from perennial springs in the Surrey sands quite free from every objection, in fact free from the greater amount of impurity which was collected by rain water. The consumption then was not more than 18 gallons per head of population, and it was demonstrated in various ways that fully three-fifths of the water now pumped into London was actually mischievous, supersaturating the subsoil with additional rainfall, and he believed that evil was still going on, and would continue until the supply was put on a public footing. As to the qualities, they depend mainly on its aëration, which tne stomach test, and not chemistry, determined. Water direct from spring sources in chalk was highly potable; taken from cisterns in which it has stagnated, it was charged with bad town air; taken from a slum in which it has been kept, it was charged with the foul air of the slum. Chemistry does not analyse such air, but the stomach does. The prisoners of Millbank Penitentiary had their supplies of water changed from a river source to a spring source, and the medical officer showed that the change was attended by a great improvement in health. Death-rates were adduced to show differences in the qualities of water; but the fact was general that the people of the wage-classes drank, not water, but beer and tea: only children drank water. Not engineering, but sanitary science took cognisance of the principle of circulation against stagnation. In none of the papers did he find any due recognition of the conditions of stagnation which made good supplies bad, and bad supplies worse; in none was there any recognition of the effects of self-cleansing house drainage, which discharged sewage fresh and undecomposed, in conditions which fed fish, and the conditions of stagnation and putrescence which killed fish.

Mr. BISCHOF said the germ theory had been referred to in one of the papers, and it almost appeared as if the authorship of that theory were imputed to Dr. Frankland He was sure if that gentleman were present he would

be the first to disclaim that idea; he had simply adopted that theory as being the one most in accordance with observed facts. He was under the impression that Mr. Mansergh's paper must have been written some time ago, or he should have expected him to go a step further, and refer to the memorable discovery, by Dr. Koch, of the comma or cholera bacillus. He did not go so far as to consider it finally proved that this bacillus was actually the cause of the cholera, but he thought it extremely likely that the further researches of Dr. Koch and other scientific men would prove that to be the case, and then, perhaps, Dr. Tidy's incredulous gaze might behold the germ itself.

Mr. MAXWELL said he wished to refer to a passage in Mr. Denton's paper in which he said that the deficit of the present year would have been more severely felt had it not been, in some measure, counterbalanced by the excessive rain which occurred during the last seven years, which left a balance to be carried over. But as far as his experience of underground water went, he did not consider that they had a bank to fall upon, or that the rainfall in previous years affected the present in the slightest degree. In the waterworks with which he was connected in the neighbourhood of Hull, which was a supply from the chalk, the wells followed very nearly the average rainfall of the three previous months. Thus in considering their present supply, he had to look at the rainfall of April, May, and June, and depend entirely upon it. Certainly, so far as the water which fell on the Yorkshire wolds was concerned, it found its way into the Humber and German Ocean, and they never could keep any stock. Mr. De Rance had advocated dummy wells, which should be fed in rainy seasons to keep up the reservoirs for dry seasons, but he was satisfied that, in his district, they would be no use. He had a peculiar instance of that three years ago, when there was a heavy snowfall about February. The water in the shafts came up as a rule at a temperature of 50°, but in the June of that year it fell to 46°, which he could not account for until it occurred to him that it was owing to the

snows, which lay a long time on the ground and then gradually melted. Mr. Latham had referred to the rapidity with which the water level fell last year, which again was an illustration of there being no storage of previous years to fall back upon. Last year, in June, there were 30 feet of water in the bottom of his shafts, in July it fell to 20 feet, and in Sepember to 7 feet. This year it came down, in May, to the same level as it was last year in August, simply because after January, which was a wet month, there came February, March, and April, exceedingly dry. He was quite satisfied that the rain of previous years was not stored up as had been suggested.

Mr. E. K. BURSTAL said he was sorry to differ from Mr. Easton with respect to the supply of water by measure, but his experience of ten years in the management of large works led him to a totally opposite conclusion, mainly on account of the expense. Taking a town of 100,000 inhabitants, one meter would be required to nearly every house, and supposing there were five persons to each house, that would require 20,000 meters, the cost of which, including fixing, would be £100,000. At five per cent. that would mean an annual charge of £5000, and he knew that an inspector could not possibly look after more than 1000 meters, so that £500 more must be added for their wages, and £5500 was a large sum to charge on such a town. Now the saving, he calculated, would not be as much as £500 a year. When he took charge of the Oxford Waterworks about five years ago, he had a similar experience to what he previously had at Derby. Oxford was using 42 gallons of water per head per diem, but he had now brought it down to almost exactly 20. A few nights ago, being desirous of learning more particularly the quantity of water used at different hours of the day, he had the whole town supplied from the service reservoir, which he had carefully gauged, and found that from twelve o'clock at night to four o'clock in the morning, when no water was really used, for there were no manufactories there, the quantity wasted was equivalent to 6 gallons per head. He

could safely say, therefore, that 14 gallons per head only was used, and 6 gallons wasted. He had already reduced it from 42 gallons to 20 gallons per head, by means of two inspectors, who had various other duties to perform. That was in a town with a population of 45,000. At Derby, with 75,000 population, he had three inspectors, and if that could be done, he thought there was no necessity for the enormous expense which would be incurred by introducing meters. Meters for measuring water were very different to gas meters. With gas you had a pressure of inches, but with water there was pressure from 150 feet to 200 feet, which made it very difficult to keep any instrument absolutely in order, and there were always disputes with reference to them. The only meter which he knew of which was a good type of a positive meter was Kennedy's, but the great objection to that was that it often let the water pass through it day after day without registering it at all. He certainly had had one in use ten years, which was never touched except to oil it, and at the end of that time it was as perfect as at the beginning; but he had had them in other places where they were often a source of annoyance. Parkinson's was very good, but it was only a low-pressure meter. Siemens's was also good, but the public did not like an inferential meter; and, in fact, there was no meter at present which would really answer the purpose, and he was quite certain their introduction would be very distasteful. In London, a reduction in the quantity consumed could easily be brought about, and the companies would be the first to co-operate, but it was necessary for the public to assist; and, unfortunately, at the present time, any one who could oppose the water companies in the police-courts and elsewhere was the popular man, and probably that would be so until the whole of the water companies were transferred to some public authority, and then it would be the old story of Stockton and Middlesbrough over again.

Mr. JABEZ HOGG remarked that London was a very exceptional city to deal with. It was useless to point out

what had been done by provincial towns, and this constituted a very serious impediment in the way of procuring a better water supply. In the first place, it would not do to ask the Government to sanction any scheme which would make London dependent on one source of supply; and, therefore, the proposal to bring water from Wales, or from a long distance, was out of the question. If there were an aqueduct bringing water from Wales, what would happen to London if some of the dynamite people determined to cut off the supply? Besides the danger there was the enormous expense. Then there came the question of how could we get a better supply than that from the Thames and Lea, for he apprehended no one would say that either of those rivers afforded London a pure and wholesome supply of drinking water; the late discussion in the press made this appear impossible. The water companies had also been accused of taking more water than they should take, thus leaving the river-bed in an exposed and dangerous state; exclusive of this, there were a million inhabitants living on the banks of the Thames, and he was surprised the Thames Conservancy should adhere to the statement that the water was comparatively pure, and free from pollution. It was said, indeed, that twenty-one towns situated on the banks were still continuing to pour sewage into the Thames. That was a statement which could hardly be denied. They certainly did not pour the whole of their sewage into the river, but a great portion of it found its way, secretly or openly, into the Thames. If any one would go up the river with him, he could point out innumerable inlets where sewage water made its way into the river, in spite of the efforts of Conservators.

Mr. E. K. BURSTAL said that was not the case above the intakes of the London water companies.

Mr. JABEZ HOGG said it could not be controverted that the Thames was miserably polluted above the intakes of the water companies. He would not throw blame upon the Conservators; they did their best; it was simply im-

possible to divert the sewage of the immense population residing on the banks of the Thames; and even taking it that the sewage went through a sewage farm, or was submitted to the A B C process, the effluent water must pass to the Thames, and was dangerous to health—not always dangerous, but supposing two or three cases of cholera were to occur high up the stream, and the dejections sent into the river, there would be the extreme danger of everyone becoming affected by cholera who might partake of the water. It had been said that the present deficient supply of the Thames might be supplemented by impounding underground water; indeed, one of the water companies obtained a considerable quantity of spring water from the gravel and subsoil, but he denied that this was pure water. With regard to the Lea, there was a letter in the *Times* that morning stating that it was shamefully polluted, the sewage farms on its banks sending in effluent sewage, most dangerous to health, and this could be seen by anyone at the trouble to go up the river. He contended it was impossible for London to look any longer for a supply of drinking water to the Thames or the Lea; there should be an immediate resort to deep well water, which could be had in unlimited quantities from the chalk, where it had been stored up for ages. It was said, however, this water was too hard; it was no doubt discreditable to rich companies to send hard water to their customers without softening it by a process which could be carried out at a small cost in their reservoirs. He considered it a great discredit that a rich company, like the New River Company, should, after sinking deep wells into the chalk, pump a very large quantity of good spring water into a river exposed to pollution, and send it on, open canal fashion, to London, or otherwise keeping it in large open reservoirs where it may become stagnant, and men and dogs may drown. It was impossible to purify such water as that, and convert it into pure and wholesome water such as the companies engaged to supply. The water he *drank* had 16 degrees of hardness, which was sufficient to

produce a large amount of calculous, a disease which he believed was very much on the increase, and besides which it did damage, and marred all domestic arrangements. Mr. Easton had spoken of the damage done to water by cisterns, but he contended that much less damage was done in that way than was alleged. He had gone very carefully through all the poor districts of St. Giles's, and visited house after house to see the condition of the cisterns, and he found that it was less due to the condition of the cisterns than to the quality of the water sent into them. He had just had his cistern cleaned out, and found a very small deposit in it; but of course his remarks applied to covered cisterns, and not to the uncovered cisterns found in some of the poorer houses. It was impossible, with the short supply of water the companies gave, for the poor people to do without cisterns altogether. He was often without water on Sundays, because a short supply of fifteen or twenty minutes daily was thought sufficient by the company.

The CHAIRMAN said he must say a word in support of Mr. Easton's statement with regard to the cisterns. He thought Mr. Hogg would have to inform himself a good deal more with regard to the real condition of cisterns in London, before speaking so decidedly as he seemed inclined to do.

Captain E. BURSTAL said he had only just come into the room, but had heard some astounding remarks, and he was quite sure Mr. Hogg must have been very much misinformed as to the real condition of the river Thames above the intakes of the water companies. That afternoon he had deposited in both Houses of Parliament a report for the year ending December, 1883, signed by the Chairman and himself, which no doubt would shortly be published, when it would perhaps be seen that there were but two towns on the banks of the Thames which passed any pollution into the river. One of these towns was Staines, and they were now beginning to do what they had had notice to do some time ago, and what they had been

prosecuted for not doing, namely, adopting some system to deal with their sewage. The other town was Henley, from which a very small quantity of sewage found its way into the river, but however small it might be, it was the duty of the Conservators to arrest it, and do everything they possibly could to prevent any pollution, and every source of pollution which had been found above the intakes of the water companies had been stopped.

Mr. HOMERSHAM said he had seen sewage from the outfall at Windsor, of a most disagreeable nature, coming into the Thames. The fact was, every drop of liquid sewage now went into the Thames; he agreed it had passed through some treatment, but if anybody contended that urine, one of the most deleterious matters that could go into water, was thereby purified, he was grossly mistaken. The sewage was purified to some small extent; but to say that no sewage entered the river, when the whole of it went in except some solid matter, was not correct. He should like to ask particularly about Reading as well as Windsor.

Mr. E. K. BURSTAL said he was the engineer who carried out the Windsor sewage arrangements, and after the precipitating process, the whole effluent was passed through land.

Mr. WALKER said he was manager of the Reading Waterworks, and had a great deal to do with the sewage works of that town. The sewage did not go into the river Thames. Reading had expended over £300,000 in diverting the sewage of the town from the Kennet, which was one of the principal tributaries of the Thames. But while Reading had done that, the sewage of Newbury, sixteen miles above the intake of the Reading Waterworks, went into the Kennet, and from thence might find its way into the Thames. From what had passed that day, he felt quite at a loss to know what would be the best source of supply;—one recommended getting it from the chalk, and then they were told the water was too hard; and if they got it from the rivers, that was too soft. With reference to

the sewage of Reading, he had simply to say that it had not gone into the Kennet for the last seven years.

A GENTLEMAN asked where it did go to.

Mr. WALKER said it went to the "Manor" Farm, and the effluent flowed into the Kennet.

Mr. ROBERT SUTCLIFF said Mr. Denton, in his paper, mentioned some supposed disadvantages attending the adoption of tube wells, namely, that if an accident happened to the pump, the supply was stopped until it was replaced, and that if the supply was insufficient, another well had to be constructed. As these points were important to the system which he had the honour to be connected with, he wished to say a word or two upon them. With regard to the first, if a pump got out of order in an ordinary dug well, as a rule, another pump must be put up in its place, but in a tube well that could be done in a few minutes. With reference to the supply running short, he could mention one town (Watford) in which some time ago they doubled the supply, their dug well having got into the very position which it was supposed the tube wells might get into, and not giving a sufficient supply; they put down a single tube well of $8\frac{1}{4}$ inches, and that gave double the supply previously obtained. In reality, having to add other tube wells has really in many cases been an advantage. Sometimes people would say they did not want to incur a great outlay at present in order to provide for future possibilities, and by having a tube well they could have a supply requisite for the present which could be added to as it was wanted. If more water were required, all they had to do was to sink two or more tube wells, and couple them to the existing arrangement. ' Being at the present time engaged in some ten deep Artesian borings, he might make a remark on the general question. There seemed to be a great difference of opinion as to whether water, after it was purified, was prejudicial or not, but he always felt that he would very much rather have water which had not been contaminated, even if the contamination were afterwards removed. His idea was to get

the water pure, and keep it pure, not to allow it to be contaminated, and then put it through a process of purification, which seemed to him to be objectionable and contrary to common sense. On the banks of the Thames, in many places, the sources which supplied the river were beautifully pure, and though he did not approve of shallow sources as a permanent supply, yet, temporarily, an enormous quantity of pure water might be found on the banks of the Thames, which went to add to its volume. In one case, even at Gravesend, within a stone's throw of the river, which was then in a most disgusting state, having put down a tube well, he had water which was analysed, and pronounced to be as pure as that of Loch Katrine. There was a vast body of this water flowing towards the Thames, and if it could be taken temporarily, it would save the water companies a great expense in filtration. This reminded him of the manner in which water was filtered. He did not know whether any of the water companies had tried passing the water up instead of down, but it seemed to him very objectionable to let all the stuff they were trying to prevent passing, be caught on the surface of the filter-beds, and let all the other water go through that. He thought the right system was adopted by one of the filter companies, in which they made all the water pass upwards through the filter, so that any sediment which might be deposited was left at the bottom, and could be easily removed.

Captain DOUGLAS GALTON, said with reference to the observation of Mr. Hogg that cisterns were not objectionable, that, if one thing seemed to have been better established than any other with reference to the water supply, it was the danger of cisterns. He did not say that cisterns might not be kept clean, but the general plan was to leave them for weeks, months, or years, without being cleaned, and then it was undoubted that however pure might be the water put into them, it would become contaminated. All who had studied sanitary matters had come to the conclusion that if possible a constant supply was the

best thing to obtain, and that such a supply would obviate the necessity for house filtration. Those impurities which were now obtained in London water were chiefly owing to the method of storing it.

Mr. HOGG said what he wished to imply was that the water supply was so short that the cisterns were drained dry every day, and therefore there could be no sediment.

Mr. CHADWICK said, living at Richmond, he had seen water running from market gardens into the river in enormous quantities, the colour of coffee, and he had gone to take a bath there, and found the water absolutely smell of manure. Many people forgot that it was not sewage alone, but the surface washings from lands heavily dressed with manures, which polluted the rivers.

Mr. EASTON said he laid so much stress on the evils of the cistern system because, when he investigated the water supply in 1877 and 1878, an immense mass of information was got from the Metropolitan Board which would have been laid before a Select Committee if the Bill had not been stopped at the second reading, and very conclusive evidence was obtained as to the filth in the cisterns. Five of the ablest chemists in England, with the Chairman at the head of them, were engaged for three or four months, not only investigating the quality of water supply in the mains of the different companies, but the mud which they took out of the cisterns, and however difficult Mr. Hogg said it was to find any deposit, he could assure him there was an ample supply of taint from all parts of London —not only from the poorer class of houses, but they found it in places where it certainly ought not to have been found, and where, if the people took proper care of the cisterns, it certainly would not have been found. With regard to the people generally, it was their misfortune that the cisterns were in such a condition; it was a consequence of the intermittent supply that this filth would accumulate. He might add that they were investigating not with a view to prove that the water in the mains was the best, but on behalf of the Metropolitan Board of Works, who had a rival

scheme, so that, if they had any bias, it was to show that the water in the mains was bad.

Mr. MACKNIGHT said there had been a great deal of discussion in Edinburgh on this question of cisterns. The Water Trust were under the necessity of bringing in a very large supply of additional water, and it so happened this was from the Moor Foot Hills, ten or twelve miles south of Edinburgh, where there were no springs; and there were loud complaints on the part of the artisans of its impurity. The Water Trust in defence got up a cry about the state of the cisterns, but they were completely beaten. Most of the houses in Edinburgh were what are called self-contained, and all had separate cisterns, which the owner took care to keep in good order, but the bad water sent into them left a deposit. All chemists knew very well that if water had certain mineral ingredients in it, after standing a short time, it would leave a deposit, but that was due to the water, not to the cisterns.

CONFERENCE ON FRIDAY, JULY 25TH, 1884.

II.—QUALITY OF WATER. FILTRATION AND SOFTENING.

Sir FREDERICK ABEL, C.B., F.R.S., in the chair:—

The CHAIRMAN, in commencing the proceedings, said the outcome of the previous day's discussion showed that there was agreement, at any rate, on some important points. All agreed that the water supply was derived from rainfall, though perhaps, with the exception of Mr. Jabez Hogg, who spoke of the illimitable supplies stored in the chalk. The importance of the systematic observations introduced by Mr. Symons, and the value of the data derived from those observations as indicating the relative abundance or scarcity of the supply of water in different districts, and their relation to the population of the districts, were also unanimously recognised. In connection with this matter very useful information had been supplied by Mr. Topley, Mr. De Rance, and Mr. Whitaker, and the maps prepared by the latter gentleman promised to be extremely valuable. There could be no doubt that a combination of careful hydrogeological surveys, with a study of rainfall observations throughout the country, would serve to enlarge our knowledge with regard to the conditions to be fulfilled for securing an efficient water supply

to different parts of the kingdom. It was only natural that the discussion with regard to the sources of supply should gravitate towards the larger towns, and more especially towards the supply of water to London, which had been of late a question of such serious controversy. Mr. Bailey Denton, however, in his interesting communication, had referred more especially to the supply of rural districts or small communities; and it might be hoped that the disinclination of local authorities, to which he referred as having stood in the way of progress, was rapidly disappearing. There could be no question that the country generally was now thoroughly alive to the necessity for obtaining for all communities, large or small, as pure a supply as could be obtained. In connection with this subject, Mr. Denton gave interesting information with regard to the application of tube wells; he might say that in connection with military matters he had had considerable experience of the usefulness of such wells, and so long as it was not necessary to apply power in connection with them, and a moderate supply only was required, their use would be attended with very considerable advantage. With regard to large towns, there was also a consensus of opinion to the effect that in order to ensure as pure a supply of water as possible, it should, if practicable, be obtained at its source, rather than after it had been more or less polluted by passing along streams and receiving surface drainage or still more objectional matters in its course. With the exception of Mr. Hogg, he also thought they were all impressed with the fact that the necessity not only for having water pure, but for keeping it until used in a perfectly pure condition, gave rise to a wide spread objection to intermittent supply, and to the consequent necessity of having tanks in houses, in which the water inevitably became more or less polluted. It was somewhat remarkable that Mr. Hogg, in his search for the minute animalcules on which he based such important conclusions, should have entirely overlooked the grosser impurities which everyone else found in the cisterns.

With regard to the supply from wells, Mr. Baldwin Latham had directed attention to two or three important points; for instance, to the necessity, in estimating the quantity to be derived from such a source, for ascertaining what was likely to be the minimum supply from those wells, and regulating the number of wells accordingly. There was no question that this might be a matter of considerable difficulty for water engineers to meet. He had also directed attention to an incidental point, which, as he (the Chairman) had pointed out, the Conference could hardly deal with, but which it was impossible to keep entirely out of sight, viz., the influence of wells in reducing the supply of water to streams in their neighbourhood, and the consequent questions of property which would arise. Upon the question whether the water supply should be taken from rivers or wells, there were great differences of opinion. Some believed that, although it would be most desirable to have water absolutely pure, yet there were considerations weighing somewhat strongly in favour of obtaining water from convenient streams, as high up the source as practicable, and to apply, in connection with such supply, the most efficient means of mechanical, and, if possible, chemical purification. Others took a somewhat poetical view with regard to the supply from deep wells, and utterly ignored the possibility of any contamination of such water, and seemed to think that you had only to sink any number of wells as close together as they could be placed conveniently, to obtain any amount of water to supply a town of any size. Those were points upon which differences of opinion would always exist until the matter was put to a practical test on a large scale. Again, many, in referring to the hardness of the water, said that companies had no business to give hard water; that they had only to adopt a softening process, which costs little or nothing; and that if a water company were allowed to supply water they should only supply it in the softest condition in which it could practically be produced. Of course that was a very natural demand from the point

of view of the consumer, but it remained to be seen how, if they drew water from deep wells for the supply of London, a softening process could be carried out on the gigantic scale which would then be necessary. With regard to that point, they looked forward to have some valuable information given them by Mr. Homersham and also by Mr. Baldwin Latham.

WATER FOR DOMESTIC USE.

By S. C. HOMERSHAM, M.Inst.C.E.

WATER for domestic use, and for distribution through pipes into dwellings in cities, towns, villages, and other places, should be derived from sources that afford adequate quantities at all seasons, characterised as being:

1. Wholesome for drinking, for culinary, and for other uses.
2. Soft without having the power to dissolve or injure lead, and well adapted for washing the person, for use in baths, and for use with soap.
3. Of a normal uniform temperature at its source equal to the average of the climate for the year, which in England differs but little from 50° Fah.
4. Well aërated, holding in solution eight or more cubic inches of gases per gallon, namely, about two of oxygen, six of nitrogen; agreeable and refreshing when drunk.
5. Clear, transparent, colourless, bright, and, when seen in large bulk, pure blue, the natural colour of uncontaminated water.
6. Unable to cause a deposit or fur in the utensil in which it may be heated or boiled.
7. Free from organisms, animal or vegetable, living or dead, and any matter in suspension.

Water in its natural or normal condition characterised by all these seven qualities may be abundantly obtained in some portions of the globe. It abounds in parts of Brazil, in parts of New South Wales, and doubtless in other

places. Such water, however is not abundant in the United Kingdom.

Here it is difficult to find a source that will yield a considerable quantity of soft water associated with the other six named qualities ; or to find a source that will yield an abundant quantity of soft water associated with qualities 1, 3, 5, 7.

Water, inland, is all derived from rains that fall on the surface. Land, composed at or near its surface of sand, gravel, chalk, and some other limestone, absorbs nearly all the rain that falls upon it and stores in its pores the greater portion below ground. Other land, consisting of clay, granite, millstone, grit, and other impervious rock, absorbs hardly any of the rain or snow that falls upon its surface. For the most part it flows off the land into valleys, and forms brooks, rivers, or floods. Sometimes the rivers or floods are collected in natural impervious hollows or basins, thus forming natural lakes.

Sometimes artificial hollows or reservoirs, or lakes, are constructed in valleys to catch and impound river and flood water, to supply or feed canals, or to be stored for domestic use. Thus the sources from which water can be obtained for the supply of a population, or for manufacture, or other uses, are—

1. Brooks, rivers, and natural or artificial lakes. These may all be called surface waters.

2. Springs that often naturally issue from the sides of valleys into brooks or rivers, and other subterranean water stored in the pores of rocks below ground, may be collected above ground or by means of wells, bore-holes, and underground adits or tunnels. Such water may all be termed subterranean or spring water. Water, however, whether surface or spring, is all derived from rain falling on land, mostly on uplands or hills. All brook, stream, or river water ultimately finds its way by gravitation into the sea through uncovered channels, or rivers, that may be seen, and are often navigable, providing inlets and outlets for vessels from the land into the ocean, or from the ocean inland.

All deep subterranean water also ultimately finds its way into the ocean, through subterranean pores, fissures, or channels, often penetrating to great depths before doing so. Thus, at present, a bore-hole at Richmond, in Surrey, derives a supply from the surface carried down to a depth of more than a quarter of a mile below the surface of the ocean. The water from this bore-hole will naturally rise to an altitude of more than 120 feet above Ordnance Datum, or the mean level of the sea.

As a rule, for domestic uses, subterranean or spring water is greatly to be preferred to river or surface water, more especially when it is derived from certain beds of sand, as then the water often possesses the whole of the seven characteristics before described. Large quantities of subterranean water, however, are derived from the chalk formation in the south and south-east of England, and in Yorkshire, and used for the supply of urban and other populations. Thus a considerable portion of inner and outer London, and numerous towns situated on or near the chalk formation, are supplied by subterranean water absorbed by the chalk. Aylesbury, Brighton, Canterbury, Charlton, Deal, Dover, Greenwich, Gravesend, Hull, Margate, Plumstead, Ramsgate, Tring, Woolwich, and many other places, are entirely supplied by spring or subterranean water obtained in this way from the chalk formation. This water has five out of the seven characteristics I have mentioned, but is wanting in two, namely, softness and non-ability to deposit fur when boiled. By a simple process, however,—invented by the late Dr. Clark, and described in a paper read before the Society of Arts on the 14th May, 1856,—both the quality of hardness and the power to deposit fur when boiled are got rid of. The process is a simple one, and has now been in practical use for more than a quarter of a century with great success. Water so treated is greatly admired and valued by those who are supplied with it.

Surface water, whether derived from brooks, rivers, or lakes, though the latter be natural or artificial, is usually

soft, and less liable to deposit a fur when boiled than most spring or subterranean water. On the other hand, it is not well adapted or so wholesome for drinking; (3) it is cold in winter and liable to freeze in distributing pipes; warm in summer, and (7) pervaded by numerous living organisms.

(5.) It is not always clear and bright without being filtered (2) and dissolves lead.

Thus, in these most important respects, spring or subterranean water is to be preferred to river, lake, or surface water. Those who care to follow this subject more in detail, will find both the quantity and quality of spring or subterranean water fully discussed in a paper I read before the Society of Arts on the 31st January, 1855.

It is obvious, also, that all brook, river, or lake water is liable to be greatly contaminated by becoming mixed with faded blossoms and fallen leaves; by mud, mainly composed of decaying vegetable matter and pervaded by numerous living organisms; by manure from off the land; by the excreta of fish, animals, and man, both liquid and solid, washed into it, and more especially in times of floods; by the action of frost and other contaminating causes that it would be difficult or impossible to prevent. Indeed, streams and rivers, in a greater or less degree, must always remain the sewer of a district, and the means by which surface washings are conveyed to the ocean.

All river, lake or surface waters, more especially in warm seasons of the year, are found to be pervaded by minute living organisms, vegetable and animal, none of which are found in uncontaminated spring water.

A paper read by Mr. Jabez Hogg, before the Society of Arts, on the 12th May, 1875, will be read with interest by those who care to pursue the subject.

In the Parliamentary Session, 1852, a body of householders deposited plans, and applied to Parliament for powers to supply a large portion of London with softened spring water at a very moderate charge for drinking and personal ablution, thus leaving the old-established com-

panies who supplied the Thames water to continue the supply of such water for watering roads, for flushing sewers and closets, and for other gross purposes. At that time, however, the Water Companies had great influence in the House of Commons, so much so, that the Government of the day, very much, as I know, to their regret, felt themselves obliged to exert their influence to prevent the powers sought being granted, in order to secure the passing of a Government measure affecting Imperial interests.

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Such Conferences and discussions as these we are now concerned with cannot fail to afford much useful information to many, and it is to be hoped will ultimately result in securing a more wholesome, a softer, and a cheaper supply carried into the dwellings of the mass of the population.

SOFTENING OF WATER.

By BALDWIN LATHAM, M.Inst.C.E., F.G.S., F.R.MET.SOC., &c.

FROM the remotest period of antiquity, of which we have any record, the art of softening water for the purposes of washing and cleansing, appears to have been known and adopted. Long anterior to the invention of soap, of which the elder Pliny gives us the earliest account, as having been first manufactured by the Gauls, caustic alkali derived from wood ashes, and from natural earths, was used as a lye. The process of making an alkaline lye was mentioned by Aristophanes (434 B.C.), and also by Plato (348 B.C.). We have also a record in the volume of Sacred Writ, in Jeremiah ii., verse 22: "For though thou wash thee with nitre and take thee much soap." The Hebrew word *borith* used in this passage is stated by authorities to refer to the vegetable lye of potash, but in another passage of Sacred Writ, Malachi iii., verse 2, where reference is made to "fuller's soap," the Hebrew word *nether* is there believed to apply to a mineral lye or soda. The people of Egypt were known to use mineral alkali and ashes of plants for the purpose of making a lye for washing from an early period, as recorded by Pliny.

Nitrum, a natural lixivious salt which is found in many southern countries, was well known, and was used for washing at a very early period. Certain plants, too, the juice of which is of a saponaceous nature, were used in early days, instead of soap. Meal and many kinds of seeds and bran were also used in connection with washing operations. The urine of various animals kept until it became stale and alkaline was used in eastern countries at a very early period; and in the Avesta, special directions are given for cleansing and purifying with the urine of the

sacred cow. Pliny, in his 'Natural History,' states that if water be nitrous or brackish, or bitter, if some fresh barley meal is put into it, that within two hours it will be so amended and sweet that a man may drink thereof; and a translation made from Pliny, by Dr. Philemon Holland, in 1634, goes on to recount that the same operation of sweetening water may be effected by a kind of chalk which is found in the island of Rhodes; and a description of clay which is found in Italy will do the same. Pliny, who died A.D. 79, records the manufacture of soap as being composed of tallow and ashes, the best being made of goat's suet and beechwood ashes. That the amount of mineral matter in water, as affecting the conditions of health, was studied at a very early period, is known from the fact that the hydrometer was probably first used for the purpose of ascertaining the quality of the water used for dietetic purposes. Although the principle of the hydrometer has been ascribed to Archimedes, there is no record of this instrument having been made by him. The earliest record, according to Beckmann, appears from a correspondence between Synesius and Hypatia, the latter of whom was assassinated, A.D. 415, in which Synesius states that he found himself so ill that he proposed to use the hydrometer, and requested Hypatia to at once procure one for him. The mode of strengthening ordinary lye by the addition of lime was known in the time of Paulus Ægineta, a physician who flourished either in the 3rd or the 7th century.

Soap is mentioned by Geber in the second century, and at a later period is frequently referred to by Arab writers, as being used not only for detergent purposes, but also for external application.

Soap is very largely used, or rather wasted, in many places in the present day for softening water. It is now well understood that no useful effect in washing is produced until sufficient soap has been used to soften the water.

For the purposes of this investigation, water may be divided into two classes, hard and soft. *Hard water* is a water which contains salts of lime, magnesia or iron, and

sometimes an amount of free carbonic acid. A hard water, commonly considered, is one that destroys soap in washing, while a soft water is one that does not destroy soap. A *soft water* may derive its properties from an absence of earthy salts, or it may have become soft by reason of the presence of certain alkaline salts in the water, notably the salts of soda and potash.

Hard waters may be divided into two classes, those which are permanently hard and those which are temporarily hard. It is often found that a single sample of naturally hard water partakes of both these properties. A water which is said to be temporarily hard becomes soft by boiling, as the hardness is due to salts of magnesia or lime dissolved in the water by the agency of carbonic acid, or due to the presence of this gas in a free state in the water. Under either circumstances, the effect of boiling the water a sufficiently long time is to drive off the carbonic acid gas. and a natural softening of the water takes place from the absence of this gas, and the earthy salts that have been held in solution by it in the water.

Water that is permanently hard derives this property from the presence of the same salts as render water temporarily hard, but instead of being combined with carbonic acid, they are combined with sulphuric acid, and to soften water that is permanently hard requires very different conditions than is the case with waters that are only temporarily hard.

The qualities of a good drinking water have been described as:—

1st. Freedom from vegetable and animal matter.

2nd. Pure aëration.

3rd. Softness.

4th. Freedom from earthy mineral or other foreign matter.

5th. Coolness and delivery at the minimum temperature.

6th. Lucidity or clearness.

7th. Absence of taste and smell.

Although many authorities insist that for the sake of

health a soft water is beneficial, on the other hand, there are those who contend that there is no evidence whatever to show that even a hard water had any influence upon health. It is clear, so far as the health statistics of this country are concerned, that if anything the results come in favour of persons inhabiting districts having hard waters. On the other hand, it has been thought that particular diseases which affect particular localities, such as cretinism and goitre, are due to certain salts of magnesia, which have been found in the waters of the district. Some waters which are of remarkable softness, in which the softness is due to the presence of certain alkaline salts, especially those of soda, may be quite unfit for drinking purposes. A type of this water is found in the well supplying the Trafalgar Square fountains, as it is stated by some authorities that the large amount of soda contained in it, if taken habitually, acts medicinally upon the kidneys. It is also unfit for washing, as the water is liable to destroy certain colours, and stains glass. It is said to be unfit for bathing, as the soda combines with the oily matter of the skin, producing a roughness and liability of chapping. Water, however, which is naturally soft, or which has been softened by means of a process like Dr. Clark's, which does not add any new element to the water, has great advantages for many purposes; it prevents incrustation of steam boilers and household utensils; it results in a saving of fuel, less wear and tear in washing linen, and in the labour of cleansing; it saves soap in all washing and cleansing operations, the water cleans better, and gives a better colour to linen; and it is also stated to lead to greater economy in tea-making and brewing, but whether this is correct or not is very doubtful, as water used for such purposes is always boiled, and when used in that state should be as soft as softened water.

The processes which have been used both in ancient and modern times for softening water may be comprised under the heads of Boiling, Chemical Processes, Distilling, Exposure, Freezing.

With regard to the supply from wells, Mr. Baldwin Latham had directed attention to two or three important points; for instance, to the necessity, in estimating the quantity to be derived from such a source, for ascertaining what was likely to be the minimum supply from those wells, and regulating the number of wells accordingly. There was no question that this might be a matter of considerable difficulty for water engineers to meet. He had also directed attention to an incidental point, which, as he (the Chairman) had pointed out, the Conference could hardly deal with, but which it was impossible to keep entirely out of sight, viz., the influence of wells in reducing the supply of water to streams in their neighbourhood, and the consequent questions of property which would arise. Upon the question whether the water supply should be taken from rivers or wells, there were great differences of opinion. Some believed that, although it would be most desirable to have water absolutely pure, yet there were considerations weighing somewhat strongly in favour of obtaining water from convenient streams, as high up the source as practicable, and to apply, in connection with such supply, the most efficient means of mechanical, and, if possible, chemical purification. Others took a somewhat poetical view with regard to the supply from deep wells, and utterly ignored the possibility of any contamination of such water, and seemed to think that you had only to sink any number of wells as close together as they could be placed conveniently, to obtain any amount of water to supply a town of any size. Those were points upon which differences of opinion would always exist until the matter was put to a practical test on a large scale. Again, many, in referring to the hardness of the water, said that companies had no business to give hard water; that they had only to adopt a softening process, which costs little or nothing; and that if a water company were allowed to supply water they should only supply it in the softest condition in which it could practically be produced. Of course that was a very natural demand from the point

of view of the consumer, but it remained to be seen how, if they drew water from deep wells for the supply of London, a softening process could be carried out on the gigantic scale which would then be necessary. With regard to that point, they looked forward to have some valuable information given them by Mr. Homersham and also by Mr. Baldwin Latham.

WATER FOR DOMESTIC USE.

By S. C. HOMERSHAM, M.Inst.C.E.

WATER for domestic use, and for distribution through pipes into dwellings in cities, towns, villages, and other places, should be derived from sources that afford adequate quantities at all seasons, characterised as being:

1. Wholesome for drinking, for culinary, and for other uses.

2. Soft without having the power to dissolve or injure lead, and well adapted for washing the person, for use in baths, and for use with soap.

3. Of a normal uniform temperature at its source equal to the average of the climate for the year, which in England differs but little from 50° Fah.

4. Well aërated, holding in solution eight or more cubic inches of gases per gallon, namely, about two of oxygen, six of nitrogen ; agreeable and refreshing when drunk.

5. Clear, transparent, colourless, bright, and, when seen in large bulk, pure blue, the natural colour of uncontaminated water.

6. Unable to cause a deposit or fur in the utensil in which it may be heated or boiled.

7. Free from organisms, animal or vegetable, living or dead, and any matter in suspension.

Water in its natural or normal condition characterised by all these seven qualities may be abundantly obtained in some portions of the globe. It abounds in parts of Brazil, in parts of New South Wales, and doubtless in other

places. Such water, however is not abundant in the United Kingdom.

Here it is difficult to find a source that will yield a considerable quantity of soft water associated with the other six named qualities; or to find a source that will yield an abundant quantity of soft water associated with qualities 1, 3, 5, 7.

Water, inland, is all derived from rains that fall on the surface. Land, composed at or near its surface of sand, gravel, chalk, and some other limestone, absorbs nearly all the rain that falls upon it and stores in its pores the greater portion below ground. Other land, consisting of clay, granite, millstone, grit, and other impervious rock, absorbs hardly any of the rain or snow that falls upon its surface. For the most part it flows off the land into valleys, and forms brooks, rivers, or floods. Sometimes the rivers or floods are collected in natural impervious hollows or basins, thus forming natural lakes.

Sometimes artificial hollows or reservoirs, or lakes, are constructed in valleys to catch and impound river and flood water, to supply or feed canals, or to be stored for domestic use. Thus the sources from which water can be obtained for the supply of a population, or for manufacture, or other uses, are—

1. Brooks, rivers, and natural or artificial lakes. These may all be called surface waters.

2. Springs that often naturally issue from the sides of valleys into brooks or rivers, and other subterranean water stored in the pores of rocks below ground, may be collected above ground or by means of wells, bore-holes, and underground adits or tunnels. Such water may all be termed subterranean or spring water. Water, however, whether surface or spring, is all derived from rain falling on land, mostly on uplands or hills. All brook, stream, or river water ultimately finds its way by gravitation into the sea through uncovered channels, or rivers, that may be seen, and are often navigable, providing inlets and outlets for vessels from the land into the ocean, or from the ocean inland.

All deep subterranean water also ultimately finds its way into the ocean, through subterranean pores, fissures, or channels, often penetrating to great depths before doing so. Thus, at present, a bore-hole at Richmond, in Surrey, derives a supply from the surface carried down to a depth of more than a quarter of a mile below the surface of the ocean. The water from this bore-hole will naturally rise to an altitude of more than 120 feet above Ordnance Datum, or the mean level of the sea.

As a rule, for domestic uses, subterranean or spring water is greatly to be preferred to river or surface water, more especially when it is derived from certain beds of sand, as then the water often possesses the whole of the seven characteristics before described. Large quantities of subterranean water, however, are derived from the chalk formation in the south and south-east of England, and in Yorkshire, and used for the supply of urban and other populations. Thus a considerable portion of inner and outer London, and numerous towns situated on or near the chalk formation, are supplied by subterranean water absorbed by the chalk. Aylesbury, Brighton, Canterbury, Charlton, Deal, Dover, Greenwich, Gravesend, Hull, Margate, Plumstead, Ramsgate, Tring, Woolwich, and many other places, are entirely supplied by spring or subterranean water obtained in this way from the chalk formation. This water has five out of the seven characteristics I have mentioned, but is wanting in two, namely, softness and non-ability to deposit fur when boiled. By a simple process, however,—invented by the late Dr. Clark, and described in a paper read before the Society of Arts on the 14th May, 1856,—both the quality of hardness and the power to deposit fur when boiled are got rid of. The process is a simple one, and has now been in practical use for more than a quarter of a century with great success. Water so treated is greatly admired and valued by those who are supplied with it.

Surface water, whether derived from brooks, rivers, or lakes, though the latter be natural or artificial, is usually

soft, and less liable to deposit a fur when boiled than most spring or subterranean water. On the other hand, it is not well adapted or so wholesome for drinking; (3) it is cold in winter and liable to freeze in distributing pipes; warm in summer, and (7) pervaded by numerous living organisms.

(5.) It is not always clear and bright without being filtered (2) and dissolves lead.

Thus, in these most important respects, spring or subterranean water is to be preferred to river, lake, or surface water. Those who care to follow this subject more in detail, will find both the quantity and quality of spring or subterranean water fully discussed in a paper I read before the Society of Arts on the 31st January, 1855.

It is obvious, also, that all brook, river, or lake water is liable to be greatly contaminated by becoming mixed with faded blossoms and fallen leaves; by mud, mainly composed of decaying vegetable matter and pervaded by numerous living organisms; by manure from off the land; by the excreta of fish, animals, and man, both liquid and solid, washed into it, and more especially in times of floods; by the action of frost and other contaminating causes that it would be difficult or impossible to prevent. Indeed, streams and rivers, in a greater or less degree, must always remain the sewer of a district, and the means by which surface washings are conveyed to the ocean.

All river, lake or surface waters, more especially in warm seasons of the year, are found to be pervaded by minute living organisms, vegetable and animal, none of which are found in uncontaminated spring water.

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health a soft water is beneficial, on the other hand, there are those who contend that there is no evidence whatever to show that even a hard water had any influence upon health. It is clear, so far as the health statistics of this country are concerned, that if anything the results come in favour of persons inhabiting districts having hard waters. On the other hand, it has been thought that particular diseases which affect particular localities, such as cretinism and goitre, are due to certain salts of magnesia, which have been found in the waters of the district. Some waters which are of remarkable softness, in which the softness is due to the presence of certain alkaline salts, especially those of soda, may be quite unfit for drinking purposes. A type of this water is found in the well supplying the Trafalgar Square fountains, as it is stated by some authorities that the large amount of soda contained in it, if taken habitually, acts medicinally upon the kidneys. It is also unfit for washing, as the water is liable to destroy certain colours, and stains glass. It is said to be unfit for bathing, as the soda combines with the oily matter of the skin, producing a roughness and liability of chapping. Water, however, which is naturally soft, or which has been softened by means of a process like Dr. Clark's, which does not add any new element to the water, has great advantages for many purposes; it prevents incrustation of steam boilers and household utensils; it results in a saving of fuel, less wear and tear in washing linen, and in the labour of cleansing; it saves soap in all washing and cleansing operations, the water cleans better, and gives a better colour to linen; and it is also stated to lead to greater economy in tea-making and brewing, but whether this is correct or not is very doubtful, as water used for such purposes is always boiled, and when used in that state should be as soft as softened water.

The processes which have been used both in ancient and modern times for softening water may be comprised under the heads of Boiling, Chemical Processes, Distilling, Exposure, Freezing.

Softening by Boiling.—Pliny, in his 'Natural History,' states that water that hath been once sodden, that is boiled, is far better than that which is raw. There is little doubt that the boiling of water, both as a means of reducing its hardness, and also to effect its purification, was very extensively practised in ancient times, and the practice of boiling water is still carried on amongst some of the older nations, such as China and parts of India, with the greatest possible advantage, both from an economical and from a sanitary point of view. The Emperor Nero (A.D. 50 to 68), both boiled water for drinking purposes, and subsequently cooled it in glass vessels to which snow was externally applied. The effect of boiling water is to liberate the carbonic acid which holds certain alkaline salts in solution, and on the liberation of the acid these salts are precipitated and forms the coating which furs our kettles, accumulates in our boilers, blocks the circulating pipes of our water-heating apparatus, and is often a source of danger, and always of expense. The effect of boiling water, in order to to soften it, can only be secured when this operation is sufficiently prolonged. The Commissioners appointed to inquire into the chemical properties of the water of the metropolis in 1851, made some experiments on the effects of boiling an artificially prepared hard water containing 13·5 grains of carbonate of lime per gallon, and it was found to decrease in hardness from 13·5 to 11·2 degrees by being heated to the boiling point; after boiling for five minutes, it was reduced to 6·3 degrees, for fifteen minutes to 4·4 degrees, for thirty minutes to 2·6 degrees, and for one hour to 2·4 degrees, so that the softening effect does not take place at once, but a prolonged boiling is required in order to produce the greatest degree of softening. In order to get rid of the temporary hardness of water, sharp boiling for not less than twenty minutes is requisite; but boiling water does not remove the hardness occasioned by the salts which are neutral; in fact the permanent hardness of the water is increased by boiling, as all the water evaporated leaves a concentration of the neutral salts in the remaining water.

It has also been shown that the alkalinity of water is more after boiling than when softening has been produced by an alkaline salt such as lime, but both have the effect of reducing the hardness to about the same degree. This increase of alkalinity after boiling is attributed to the concentration of the neutral salts consequent on the loss by evaporation. The temporary salts held in solution by water are precipitated by boiling, and it is these precipitated salts which cause the furring of kettles, hot-water boilers, steam boilers, and hot-water pipes, and have led to the adoption in certain cases of means either for retaining the salts in solution in the water or of preventing their deposit in steam boilers, but as a rule with only partial success.

Chemical Processes of Softening Water.—In a paper read before the Literary and Philosophical Society of Manchester in 1781, by Thomas Henry, F.R.S., a description is given of a mode of preserving sea-water by means of quicklime, in which the author pointed out that the earthy base of magnesia was precipitated in sea-water by lime, and its place taken by a calcareous salt. He also referred in this paper to the well-known action of quicklime on common water as a preservative. The effect of the lime, doubtless, upon the sea and fresh water was to induce abundant precipitation, which dragged down with it certain organic impurities, and as a consequence the water remained free from putrefactive influence afterwards, as was clearly shown in the course of his experiments.

The first patent for purifying water by chemical agency in this country was taken out in 1838, for precipitating by muriate of zinc and salts of soda, the latter salts precipitating the zinc from the water, leaving the water in a purified state.

In 1841, Dr. Thomas Clark, of Aberdeen, took out a patent for his well-known and beautiful process for softening water, and which has, more or less, been the basis of all other patented processes of this description which have been adopted since that period. Dr. Clark thus describes

his process, in a paper published in the *Journal of the Society of Arts* of the 16th May, 1856:—

"In order to explain how the invention operates, it will be necessary to glance at the chemical composition and some of the chemical properties of chalk, for while chalk makes up the great bulk of the matter to be separated, chalk also contains the ingredient that brings about the separation. The invention is a chemical one for expelling chalk by chalk. Chalk, then, consists, for every one pound of sixteen ounces, of lime nine ounces, carbonic acid seven ounces.

"The nine ounces of lime may be obtained apart by burning the chalk, as in a lime-kiln. The nine ounces of burnt lime may be dissolved in any quantity of water not less than 40 gallons. The solution would be called lime-water. During the burning of the chalk to convert it into lime, the seven ounces of carbonic acid are driven off. This acid, when uncombined, is naturally volatile and mild; it is the same substance that forms what has been called soda-water when dissolved in water under pressure.

"Now, so very sparingly soluble in water is chalk by itself, that probably upwards of 5000 gallons would be necessary to dissolve one pound of sixteen ounces; but by combining one pound of chalk in water with seven ounces additional of carbonic acid—that is to say, as much more carbonic acid as the chalk itself contains—the chalk becomes readily soluble in water, and when so dissolved is called bicarbonate of lime. If the quantity of water containing the one pound of chalk with seven ounces additional of carbonic acid were 400 gallons, the solution would be a water of the same hardness as well-water from the chalk strata, and not sensibly different in other respects.

"Thus it appears that one pound of chalk, scarcely soluble at all in water, may be rendered soluble in it by either of two distinct chemical changes; soluble by being deprived entirely of its carbonic acid when it was capable of changing water into lime-water, and soluble by com-

bining with a second dose of carbonic acid, making up bicarbonate of lime.

"Now, if a solution of the nine ounces of burnt lime, forming lime-water, and another solution of the one pound of chalk and the seven ounces of carbonic acid, forming bicarbonate of lime, be mixed together, they will so act upon each other as to restore the two pounds of chalk, which will, after the mixture, subside, leaving a bright water above. This water will be free from bicarbonate of lime, free from burnt lime, and free from chalk, except a very little, which we keep out of account at present for the sake of simplicity in this explanation. The following table will show what occurs when this mutual action takes place:—

Agents.			Products.	
Bicarbonate of lime in 400 gallons	Chalk	16 oz.	= 16 oz. of chalk	= 2 lbs.
	with carbonic acid	7 oz.	= 16 oz. of chalk	
Burnt lime in 40 gallons of lime-water	.	9 oz.		

"A small residuum of the chalk always remains not separated by the process. Of $17\frac{1}{4}$ grains, for instance, contained in a gallon of water, only 16 grains would be deposited, and $1\frac{1}{4}$ grains would remain. In other words, water with $17\frac{1}{4}$ degrees of hardness arising from chalk, can be reduced to $1\frac{1}{4}$ degrees, but not lower.

"These explanations will make it easy to comprehend the successive parts of the softening process.

"Supposing it was a moderate quantity of well-water from the chalk strata around the metropolis that we had to soften, say 400 gallons. This quantity, as has already been explained, would contain one pound of chalk, and would fill a vessel 4 feet square by 4 feet deep.

"We could take 9 ounces of burnt lime made from soft upper chalk; we first slack it into a hydrate by adding a little water. When this is done, we would put the slacked lime into the vessel where we intend to soften, then gradually add some of the water in order to form lime-water. For this purpose at least 40 gallons are necessary, but we *may* add water gradually till we have added thrice as much

as this; afterwards we may add the water more freely taking care to mix intimately the water and the lime-water or lime. Or we might previously form saturated lime-water, which is very easy to form, and then make use of this lime-water instead of lime, putting in the lime-water first and adding the water to be softened. The proportion in this case would be one bulk of lime-water to ten bulks of the hard water.

"It is of importance that the lime, or lime-water, that is the softening ingredient, be put into the vessel first, and the hard water gradually added, because there is thus an excess of lime present up to the very close of the process, and this circumstance is found to render the precipitation of the carbonate of lime produced in the process more easy.

"But what you will wish to know now is, by what mark is the conductor of the process to find out when there is enough of water to take up the last of the excess of lime, so as to be enough, but no more.

"This is done by what has been called the silver test, the only test necessary to the operator after the process is fairly set a-going. This test is a solution of nitrate of silver, in twice-distilled water, in the proportion of an ounce per pint. In making use of the silver test with ordinary waters, we get a white precipitate; but if the water have in it a notable excess of lime-water, there is a light reddish-brown precipitate produced; but if the excess be very slight, we only get a feeble yellow precipitate. The way we make use of the test is to let two or three drops of it fall on the bottom of a white tea-cup; then add the water somewhat slowly; then if there be the slightest excess of lime, a yellow colour will show itself."

It may be here mentioned that a more delicate test than the silver test for ascertaining if there is an excess of lime in the water, consists in using a solution of cochineal, the natural colour of which is yellowish-red, which is turned violet in the presence of alkalies; and other agents are now used to show, by distinct colour, or its absence, if there is an excess or not of lime in the softened water.

According to Dr. Clark's scale, one degree of hardness means that there is one grain of chalk in a gallon of water. According to the scale introduced by Dr. Frankland, in the sixth report of the Rivers Pollution Commissioners, parts per 100,000 are used, or one grain of chalk in 100,000 grains of water, so that it is necessary, in considering the reports of the Rivers Pollution Commissioners, to bear in mind this difference of degrees of hardness. To reduce the hardness to parts per gallon, or to the Clark scale, it is necessary to multiply by 7 and divide by 10.

Hard water decomposes soap. The amount of soap ascertained by Dr. Clark to be wasted before softening the water, is equivalent to 2 ounces for each degree of hardness for every 100 gallons. Dr. Clark introduced a soap test, or a means by which a solution of soap is made to at once indicate the degree of hardness of a water. When pure chalk is burnt into lime, one pound is converted into 9 ounces of lime, and this quantity is soluble in 40 gallons of water. Beyond this, lime is not soluble in water, so that clear lime-water always possesses a known composition. This amount of lime is equivalent to 98·43 grains per gallon. As one particle of lime will remove $\frac{16}{9} = 1 \cdot 777$ of chalk, it follows that $98 \cdot 43 \times 1 \cdot 777 = 174 \cdot 9$, or the number of gallons of water one degree of hardness which one gallon of lime water will soften. In practice, however, while theoretically 175 gallons of water of one degree of hardness may be softened by one gallon of lime-water, owing to the impurities in the lime, probably not more than 130 to 150 gallons would be softened, so that, to arrive at the amount of lime-water necessary to soften hard water, if we divide 130 by the degrees of hardness according to Clark's scale, it will, generally, roundly represent the number of gallons of water which can be softened by one gallon of lime-water.

It is found in practice that neither by boiling nor by the time process can all the hardness which is termed "temporary hardness" be removed; in fact, a small quantity of chalk, to the extent of one part in 50,000 parts, is soluble in water, and still remains in solution after the process. In

practice, however, 10–11ths of the whole of the temporary hardness may be removed by the lime process. In carrying out the Clark process, the lime-water is usually applied owing to the fact that it is a standard liquid containing a known quantity of lime, although cream of lime is sometimes used with advantage. Large tank space is required to carry out the Clark process, three tanks ordinarily being required, one for filling up, another for drawing down, and a third in reserve while cleansing is going on, and each tank should hold a day's supply.

It is a point of importance to know that the salts of iron may be readily removed by the application of lime. This the author found in the case of a water works at Horsham, where the water was so highly charged with iron, that everything it touched was discoloured; but by the application of lime the whole of the iron was removed. It should also be noted that the process has a marked effect in removing organic matter from water. This was shown by the Rivers Pollution Commissioners and by the analysis published by Professor Wanklyn, especially in the marked diminution in the amount of albuminoid ammonia. The great objection raised against soft water has been its liability to produce lead poisoning; but the consensus of opinion is that water softened by the Clark process is not liable to attack lead, which is a point of very considerable importance in favour of the process.

Dr. Clark's process was first carried out by the Woolwich and Plumstead Waterworks Company, where it was shown that the water was successfully softened from 23 degrees to 7 degrees. These works were subsequently bought by the Kent Waterworks Company, and the process of softening the water was discontinued. An experiment was also made at the Chelsea Waterworks Company's works, the result of which is set forth in the following Table:—

THAMES WATER AT THE CHELSEA WATERWORKS.

1851.		Degrees of Hardness.		Remarks.
		Before liming.	After liming.	
February	24	14·0	4·5	The river was in good condition. The mixing was completed in 10 hours.
March	1	14·1	3·75	The river was in good condition. The mixing was completed in 9¾ hours.
,,	18	10·5	5·0	The river was in flood, and the flood tinge was retained after liming.
,,	22	11·6	4·8	Recovering from flood. The yellow flood tinge not removed.
April	17	15·5	3·6	The river in an average condition.

In the course of experiments made in softening various waters, it was observed that, if the water was at all tinted, the softening process did not clear it; but there was a tendency for the matters separated to remain in suspension in such water, so that it was considered expedient, in softening river-water, that the water should be filtered until quite bright before it undergoes the softening process.

It may be here mentioned that, in 1852, a patent was applied for (W. B. Bowditch) to treat water with clay and alkali, and subsequently filtering.

Mr. Phillip H. Holland, M.R.C.S., late Inspector to the Burial Act Office, suggested, as an addition to the Clark process, the use of oxalate of ammonia or soda, to further reduce the hardness of the water after treatment by this process. The use of carbonate of soda for softening water has been known throughout the whole country by tea-makers from an early period. This salt added to water acts on the bicarbonate of lime and magnesia, and precipitates chalk and carbonate of magnesia. It also decomposes the sulphates of lime and magnesia, precipitating the lime and magnesia, while the soda remains in solution, so that the permanent hardness of the water is reduced by the use of this salt. The Rivers Pollution Commissioners of 1874 state, in their sixth report, with

reference to the use of carbonate of soda, that "the hardness of water is almost exclusively caused by the presence in solution of the bicarbonates and sulphates of lime and magnesia. These salts are all decomposed by carbonate of soda, slowly in the cold, but rapidly when the water is hot, insoluble carbonates of lime and magnesia being deposited or precipitated as a fine mud, while soluble bicarbonate and sulphate of soda are formed." The process, however, of using soda is much more expensive than the ordinary lime process, above $4\frac{3}{4}$ times as much soda being required to produce the same results as in the case of lime. An old receipt for softening water, and useful for some domestic purposes, is as follows:—Dissolve 6 lbs. of pearl-ash or sub-carbonate of soda in a gallon of soft water, boil the solution, and when boiling add 2 ozs. of soap, and stir until all the soap is dissolved. When this solution is added to water to be softened, the carbonate of soda and the soap combining with the salts producing both temporary and permanent hardness, form an insoluble compound by the combination with the soap, which coagulates and rises to the surface of the water, and may be skimmed off.

As any of the earthy alkaline earths may be used instead of, or in addition to, lime, it is not surprising that, since the date of Clark's patent, numerous patents have been taken out for softening and purifying water in which lime, in combination with other alkaline earths, have been proposed. For example:—

In 1849, Mr. John Horsley took out a patent for the use of calcined or caustic barytes, phosphate of soda, oxalic acid, or preparations of these substances.

In 1850, lime, in combination with chloride of barium, was patented.

In 1852, hydrate of potass and hydrate of soda, clay, and alkalies were the subject of separate patents.

In 1853 and 1854, hydrate of barytes, and hydrate of strontia formed the subject of patents.

In 1855, a patent was taken out for a powder containing

oxalate of ammonia, peroxide of manganese, and charcoal.

In 1856, silicate of soda, in combination with carbonate of soda, was patented.

In 1856, bicarbonate of soda and oxalic acid, in crystals, were again proposed to be used.

In 1856 and 1857, carbonic acid was proposed to be introduced in conjunction with hydrate of lime.

In 1860, bicarbonate of soda and silicate of soda were again twice patented.

In 1862, the ordinary lime process was re-patented.

In 1863, the use of chloride of barium was patented.

In 1865, hypermanganate of potash, carbonate of soda, alum and neutralised aluminite, or a solution of iron was proposed; and in another patent, sequi-sulphate of alumina was proposed as a means of purifying water. In another patent taken out in 1865 the use of soda and lime is again patented.

In 1866, a patent was taken out by a Mr. J. W. Tobin for an improvement on the Clark process for mixing the lime and filtering.

In 1866, the use of chlorine and permanganates, in combination with any alkaline earth, was patented.

In 1867, a patent was taken out for a preparation in a portable form, consisting of marsh mallow, linseed, bran, starch, gum, or any softening emollient, for the purpose of softening water for ablution purposes.

In 1868, the use of barytes was again patented, and the precipitate removed in vessels of a cellular form.

In 1869, the use of steam applied to water as a means of softening it was patented, the particles subsiding on shelves arranged in a vertical vessel.

In 1872, unslaked lime and sulphate of soda were patented as a means of purifying water.

In 1873, the lime process, in conjunction with a mixing and filtering arrangement, was patented; also lime, carbonate of soda, chloride of barium, or other reagent in conjunction with filtering.

In 1874, the treating of water with lime and carbonate of soda in combination with filtration was proposed.

In 1875, the lime process pure and simple, and in combination with other reagents and filtering, was patented.

In 1876, the lime process in combination with filter presses was first patented by Mr. Porter.

In 1877, the use of oxide of magnesia and basic carbonate of magnesia was proposed; also the use of a carbonate of potassa, silicate of soda, and nitre cake, used separately or combined.

In 1878, a patent was taken out for combining bicarbonate of soda with the lime process, and filtering upon the Porter-Clark plan.

In 1879, Mr. Porter took out an additional patent for carrying out automatically the softening and purifying of water. In the same year phosphoric acid and phosphate of lime were proposed as a means of softening water.

In 1880, the means of automatically carrying out the softening process, and adjusting the quantities by means of an arrangement of ball valves in a cistern, was patented.

In 1881, Mr. Porter took out a further patent for the automatic regulation of the supply of the solution of lime.

In 1881, Mr. Atkins took out a patent for treating water with lime, and subsequently filtering through a specially constructed filter.

In 1882, an apparatus for softening and clarifying water was proposed, in which sloping shelves in a vertical vessel were used, the water entering the bottom of the vessel and flowing off at the top; or concentric cylinders overflowing from one to another might also be used with the same object.

In 1883, Messrs. Gaillet and Huet's apparatus for softening water was patented, consisting of sloping and V-shaped shelves in a vertical vessel, the water entering at the bottom and flowing out at the top.

The use of steam and caustic soda was also patented.

A patent was also taken out for the use of phosphate of soda, and an apparatus for measuring the water and lime to be used in the softening process.

Modern Inventions for Softening Water.—The modern inventions for carrying out the Clark process may be described as the application of machinery to the saving of time, space, and labour. Of those in general use, dealing with them in the order of date, the Porter-Clark process comes first. In the ordinary Clark process, lime-water, in known quantity, is first admitted into a tank, to which the water to be softened is added. However, in some cases the lime-water and the hard water are allowed to flow in together into the tank, but it was considered by Dr. Clark to be an advantage, in carrying out his process, for the hard water to be brought into contact with an excess of lime-water in the first instance, which was let into the tank before the water to be softened was added. In the ordinary Clark process, not less than sixteen hours were required for the softening and subsidence of the matters separated from the softened water. In the Porter-Clark process, instead of allowing the particles of carbonate of lime to separate and subside, a brisk agitation is maintained, so that these particles remain in suspension to permit chemical reaction with the lime, and the purification of the hard water, which, when completed, is passed onward to filter presses, where the carbonate of lime adheres to the filtering cloth. The subsequent operations of filtering through the deposit on the cloth then takes place, and the water is passed away at once in fit state for use, so that the process is continuous in its action, and may be carried on just as quickly as water can be pumped from a well, provided the apparatus is of sufficient capacity to allow time for the water to remain in contact with the lime in passing through the machine. The lime in this case is passed through horizontal cylinders, which are termed lime-churns, and is constantly churned up with water, and the lime-water so made is, by suitable arrangements, allowed to mix with the ordinary water in proper proportions, after which it is again agitated. Mr.

Porter has also an apparatus by which, instead of using ordinary filter presses, he can use filter frames, and where power is not available, he also suggests a means of working the process without such power. In some cases the power obtained from the pressure of the water is utilised for working the apparatus. An apparatus of this description may be seen at the Camden Town locomotive sheds of the London and North Western Railway, and the apparatus may also be seen at work within this Exhibition.

The Atkins Process is also a modification of the Clark process, by which the space formerly required is reduced. The lime is put into a vessel where lime-water is formed, and this water is allowed to mix in its proper proportion with the water to be softened in a specially arranged mixing vessel, after which it passes into a reservoir of small dimensions. From this reservoir it is conveyed to filtering vessels which contain a special arrangement of filter, consisting of a series of chambers mounted upon a central hollow shaft, these disc chambers being covered with prepared canvas, upon which the deposit of chalk, &c., adheres, and through which the softened water filters. The filters are cleansed by means of revolving brushes. The apparatus does not require power to maintain it while at work, the only power used being that necessary to give motion to the brushes when the apparatus is cleansed. The system may be seen at work at the Henley-on-Thames Waterworks, and at other places.

In the Process of M. Maignen, a powder is used which the inventor calls "Anti-calcaire." This powder is made of variable composition in order to suit the special characteristics of the water to be treated, the ingredients used for ordinary hard water being lime, soda, and alum in suitable proportions. In the apparatus, which is at work at the International Health Exhibition for softening water for some of the breeding tanks, the water entering the apparatus gives motion to a water-wheel, which in its turn works an arrangement for distributing a given quantity of the softening agent, and causing it to pass into the water.

The water is then allowed to subside in a small tank, and is eventually filtered through filters covered with asbestos cloth, the basis of the filter being similar to that of the "Filtre Rapide." A part of the carbonate of lime and magnesia deposited from the water adheres to the filtering surface, and the softened water filters through it. The apparatus may be seen at work in this Exhibition.

The Process of Messrs. Gaillet and Huet.—In this process, which was patented in February, 1883, the patentees make use of certain known agents, the patent itself applying to the apparatus used for the purpose of producing the results after the chemicals have been applied. The agents they propose are lime and caustic soda. Whenever the water contains organic matter, they use salt of alumina or iron in addition. Iron, however, is not recommended in any case where the water is required for washing purposes. The apparatus consists, virtually, of a series of tanks in duplicate, in which the chemicals are mixed, and these enter a vertical pipe in proper proportion to the water to be softened, and which communicates with the bottom of an upright chamber divided by a series of sloping shelves, through which the water gradually works upwards in a zig-zag path. These shelves slope in one direction, and are of V shape, so that as the deposit takes place it accumulates at one point, at which there is an opening ordinarily closed by a tap, and when any tap is open the deposit on the sloping shelf communicating with it is washed out. The apparatus appears to be extremely simple in its design, but its efficiency has yet to be tested, although it is at work at Messrs. Duncan's, Victoria Docks, where the water is reduced from 24 degrees to 6 degrees and the Thames water is reduced from 16 degrees to 2 degrees.

Purification by Distilling.—It is not necessary to devote any large amount of attention to the question of purifying water by the process of distillation. The process is one which has been used from remote periods in order to produce absolutely pure water, and during the last forty years very great improvements have been adopted in order

to bring this process into more general application in connection with the purposes of water supply. The difficulty of obtaining absolutely pure water is practically exemplified by this process, for in attaining this result, unless the water is distilled some two or three times, and every time a large proportion of the residue is discarded, pure water cannot be obtained. In the case, however, of water distilled for dietetic purposes, it is not necessary to carry out the process to the extent required in procuring water for some chemical purposes. It has generally been considered that distilled water lacks aëration, and on this account it has been strongly recommended that it should be filtered. The great improvements in the process of distillation are due to Dr. Normandy, whose first patent, taken out in 1851, has been improved upon by many subsequent patents. The process has been adopted with the greatest possible advantage in many of our ocean steamers, and the preservation of the health of the crews and passengers visiting countries liable to the ravages of epidemic disease is, in a great measure, due to the use of this process. It is generally believed by many high sanitary authorities that if this system were adopted at malarious stations, one of the largest channels by which infection is disseminated would be effectually closed. Dr. Macnamara states that on our ocean steamers, "as a general rule, condensed sea-water is employed for drinking purposes, which, although it may not be always very palatable, must obviously be free from all chance of choleraic contamination;" and this is one of the great safeguards to Europe against the spread of cholera.

Softening by Exposure.—The exposure to the air of water containing salts which are held in solution by carbonic acid causes a loss of carbonic acid. Water of deep wells which has been in contact with chalk and other rocks often contains free carbonic acid by exposure, especially under the inequalities of diurnal temperature, the original charge of ground air is got rid of, and pure atmospheric air takes its place. On exposure to air, hard waters are especially

liable to develop vegetable growth. A few days' exposure of very hard water in the summer time will soon develop green confervoid growth, and so soon as this growth takes place, carbonic acid is rapidly used up by it, so that the bicarbonates in the water are soon converted into simple carbonates, and are precipitated. Water, therefore, exposed to air undergoes a chemical metamorphosis; the bicarbonates of lime and magnesia are converted into carbonates, and are precipitated, and it is in this way that exposure assists in softening water.

Softening by Freezing.—Pliny, speaking of the quality of water and of the controversy going on in his time amongst physicians as to the use of water, says that some people preferred rain-water above all others, because it is the lightest. He also says that some prefer "snow-water before that which cometh down in showers; and the water of ice dissolved before the other of melted snow," and he goes on to say that the rain, snow, and ice are all lighter than those which spring out of the earth, and ice amongst the rest far lighter than any water in proportion. Ice taken from hard or other impure waters, if found to be perfectly crystalline and free from air bubbles, will produce, on melting, a water as soft as that of distilled water. If, however, the ice contains air bubbles or cavities of any description, such water will not be entirely pure. Some years ago the author made an extensive series of experiments upon the degree of purity which might be arrived at by freezing water, when it was shown that the act of freezing may be carried to such an extent as to produce, in the remaining water, a precipitation of the salts in solution; but ice frozen upon very superficial water was found liable to have the impurities frozen in it which adhered to the under sides of the ice, and which became embedded in it by subsequent freezing; but water which has been largely deprived of air by boiling or exposure, upon being frozen, if perfectly crystalline, will produce absolutely pure water. Several patents have been taken out with a view to freezing sea-water so as to furnish a supply of fresh water

on board ship, but such processes will not compete, from an economical point of view, with the process of distillation.

Geological.—The geological formations which furnish water of a quality suitable to be softened are those of the dolomitic or magnesian limestone, which gives great hardness to water, for while salts of lime render water hard and troublesome, in washing, those of magnesia cause the water to curdle, and render it considerably more disagreeable for washing and ablution. The mountain limestone, which is ordinarily of an impermeable nature, does not yield water of such a hard quality as those of the magnesian limestone. The waters of the oolite and chalk are chiefly hard from what has been termed temporary hardness, that is due to the presence of bicarbonates of lime and magnesia in the water, which may be got rid of by boiling, or by the lime process. The waters of the new red sandstone and Permean beds vary considerably in hardness ; many of them have a considerable permanent degree of hardness, but there are none of them which may not be softened to a great extent by the adoption of the lime process, while this process, in combination with the other alkaline earths, such as soda, when the water is not intended to be used for dietetic and washing purposes, will still further reduce the hardness of these waters.

The surface wells of the country, usually sunk in drift covering various geological formations, furnish water of various degrees of hardness. Scarcely any such wells yield a soft water, and in most instances, when these wells are sunk in populous places, in addition to their natural hardness, the waters are highly polluted, and such waters ought never to be used for dietetic purposes, unless they are first boiled.

ON THE DETECTION OF SEWAGE CONTAMINATION BY THE USE OF THE MICROSCOPE, AND ON THE PURIFYING ACTION OF MINUTE ANIMALS AND PLANTS.

By H. C. Sorby, LL.D., F.R.S.

By studying with the microscope the solid matters deposited from the water of a river, the previous contamination with sewage can usually be detected without any considerable difficulty. If the amount be serious, the characteristic particles of human excrement can easily be seen; and even if it is small, and has been carried a long way by the current, it can usually be recognised by means of the hairs of oats derived mainly from the droppings of horses, which resist decomposition for a long time, and are not consumed as food by minute animals. I, however, do not propose to enter into detail in connection with this part of my subject, but specially desire to call attention to the connection between the number of minute animals and plants, and the character of the water in which they live, and also to their influence in removing organic impurities.

For some time past I have been carefully ascertaining the number per gallon of different samples of river and sea-water, of the various small animals which are large enough not to pass through a sieve, the meshes of which are about $\frac{1}{150}$th part of an inch in diameter. The amount of water used varies from ten gallons downwards, according to the number present. By the arrangements used there is no important difficulty in carrying out the whole method in a satisfactory manner. I confine my remarks entirely to general mean results.

The chief animals met with in fresh water are various *entomostraca*, rotifera, and the worm-like larvæ of insects.

I find that the number per gallon and percentage relationships of these mark, in a most clear manner, changed conditions in the water, the discharge of a certain amount of sewage being indicated by an increase in the total number per gallon, or by an alteration in the relative numbers of the different kinds, or by both. All my remarks apply to the warm part of the year, and not to winter.

It is known that entomostraca will eat dead animal matter, though probably not entirely dependent on it. I have myself proved that they may be kept alive for many months by feeding them on human excrement, though they soon died without it. If the amount of food in any water is small, not many of such animals can obtain sufficient; but if it be abundant, they may multiply rapidly, since it is asserted that in one season a single female cyclops may give rise to no less than four thousand millions of young. In stagnant muddy ponds, where food abounds, I have found an average of 200 per gallon. In the case of fairly pure rivers the total number of free-swimming animals is not more than one per gallon. I, however, found that where what may be called sewage was discharged into such water the number per gallon rose to 27, and the percentage relationships between the different groups of entomostraca were greatly changed. In the Thames at Crossness, at low water, the number was about six per gallon, which fell to three or four at Erith, and was reduced to less than one at Greenhithe.

There is, however, a very decided limit to the increase of entomostraca when the water of a river is rendered very impure by the discharge of too much sewage, probably because oxygen is deficient, and free sulphide of hydrogen present. Such water is often characterised by the great number of worm-like larvæ of insects. Thus, in the Don, below Sheffield, in summer, I found the number per gallon, of entomostraca, only about one-third of what it is in pure waters; whilst, on the contrary, the number of worm-like larvæ was more than one per gallon.

Now if the minute free-swimming animals thus increase when a certain amount of sewage supplies them with ample food, it is quite obvious that they must have a most important influence in removing objectionable impurities. The number of the excrements of entomostraca in the recent mud of such rivers as the Thames is most surprising. In one specimen, from Hammersmith, I found that there were more than 20,000 per grain; and the average number at Erith, in August, 1882, was above 7000, which is equivalent to about 200,000 per gallon of water at half-ebb, from the surface to the bottom. This enormous number must represent a very large amount of sewage material consumed as food; and though, as in the case of larger animals, a considerable part of their excrements no doubt consists of organic matter capable of putrefaction, yet there can be no less doubt that the amount entirely consumed in the life processes of the animals is also great.

As named above, I kept cyclops alive for many months by feeding them on human excrement. It is thus easy to understand why, when they abound in the Thames, the relative amount of human excrement is very considerably less than in the winter, when their number must be much smaller.

We thus appear to be led to the conclusion that when the amount of sewage discharged into a river is not too great, it furnishes food for a vast number of animals, which perform a most important part in removing it. On the contrary, if the discharge be too great, it may be injurious to them, and this process of purification may cease. Possibly this explains why in certain cases a river which is usually unobjectionable may occasionally become offensive. It also seems to make it clear that the discharge of rather too much sewage may produce relatively very great and objectionable results.

Though such comparatively large animals as entomostraca may remove much putrefiable matter from a river, we cannot suppose that, except incidentally, they remove such very minute objects as disease germs, but it would be

a subject well worthy of investigation to ascertain whether the more minute infusoria can, and do, consume such germs as a portion of their food. If so, we should be able to understand how living bodies, which could resist any purely chemical action likely to be met with in a river, could be destroyed by the digestive process of minute animals. Hitherto I have had no opportunity for examining this question critically, but have been able to learn certain facts which, at all events, show that it is well worthy of further examination. It is only during the last month that I have paid special attention to the number of the larger infusoria, and various other animals of similar type, met with per gallon in the water of rivers and the sea, which can be seen and counted by means of a low magnifying power. At low water in the Medway above Chatham, in the first half of June, the average number per gallon has been about 7000, but sometimes as many as 16,000. Their average size was about $\frac{1}{1000}$th of an inch. Possibly the number of still more minute forms may be equally great; but, even if we confine our attention to those observed, we cannot but conclude that their effect in removing organic matter must be very considerable; and judging from what occurs in the case of larger animals, those $\frac{1}{1000}$th of an inch in diameter may well be supposed to consume as food, particles of the size of germs. Up to the present time, I have however collected so few facts bearing on this question, that it must be regarded merely as a suggestion for future inquiry.

So far, I have referred exclusively to the effect of animal life. Minute plants play an important part in another way. The number per gallon of suspended diatoms, desmids, and confervoid algæ is, in some cases, most astonishing, and they must often produce much more effect than the larger plants. As far as I have been able to ascertain, their number is, to some extent, related to the amount of material in the water suitable for their assimilation and growth. In the mud deposited from pure rivers their number is relatively small, but in the district of the

Thames, where the sewage is discharged, I found that in summer their number per grain of mud at half-ebb tide was about 400,000, which is equivalent to above 5,000,000 per gallon of water. This is two or three times as many as higher up or lower down the river, and, out of all proportion, more than in the case of fairly pure rivers like the Medway. Their effect in oxygenating the water must be very important, since, when exposed to the light, they would decompose carbonic acid, and give off oxygen, under circumstances most favourable for supplying the needs of animal life, and counteracting the putrefactive decomposition so soon set up by minute fungi when oxygen is absent.

Taking, then, all the above facts into consideration, it appears to me that the removal of impurities from rivers is more a biological than a chemical question; and that in all discussions of the subject, it is most important to consider the action of minute animals and plants, which may be looked upon as being indirectly most powerful chemical reagents.

ON THE CHEMISTRY OF POTABLE WATER.

By PROFESSOR ODLING, M.B., F.R.S., F.R.C.P.

President of the Institute of Chemistry.

I.—SOURCES OF WATER SUPPLY.

THE water of most towns is derived, as is well known, from one or other of three typical sources, constituted respectively by springs, or streams, or lakes, this last named source being taken to include not only natural lakes, but also those huge artificially formed reservoirs, in which the surface water collected from more or less extensive gathering grounds, is retained by means of

embankments, and stored up for distribution to consumers. Although some streams, indeed, are fed largely by springs, and some lakes are little else than local expansions of streams or rivers, still a general distinction in character between supplies derived from the three just spoken of typical sources, is, on the whole, broadly recognisable ; and this, notwithstanding the fact of the considerable differences in composition manifested by individual spring-waters, derived from different springs or wells, by individual stream-waters, derived from different streams or rivers, and by individual lake-waters, derived from different lakes or reservoirs. Despite the marked preference of a few authorities for some one variety of source to the exclusion of the others, the majority of engineers have come to recognise each variety as having its own characteristic excellencies and concomitant defects, and are accordingly ready to avail themselves, in different cases, of whatever kind of source is rendered by local circumstances most available and suitable for the particular town to be supplied. From all three varieties of source alike, numerous large populations have been furnished for generations past, with an abundant, and, as the result has shown, with a satisfactory and wholesome supply of water ; although, indeed, in a few special instances, supplies from all three varieties of sources alike have, in different ways and under exceptional circumstances, proved detrimental to the health, and even, in certain cases, fatal to the lives of some among the population supplied. All three varieties of source have, under the best advice of the time, been continually resorted to from the earliest period of water supply undertakings, nearly three centuries ago, down to the present day. Thus, while the youngest of the companies supplying London has obtained its supply, since 1862, wholly from deep wells sunk in the chalk, the new works for the supply of Liverpool and Manchester respectively, which may both take rank among the greatest hydraulic undertakings of the century, are intended to introduce and distribute river-water in the one town and lake-water in the other. All experience, indeed, goes to show that the

supply of excellent water is not confined to its supply from any single variety of source; and that for the purpose of water supply, there are alike good wells and bad wells, good lakes and bad lakes, good rivers and bad rivers. Just, moreover, as the best of river-waters or lake-waters will fall short in regard to an excellency characteristic of well-water, so will the best of well-waters fall short in regard to an excellency characteristic of lake-water or river-water. The comparison of the one sort with the other sorts of water must be made as a whole. To select arbitrarily the special good point of one sort of water as a standard, to the neglect of the countervailing good points of other sorts, and to measure the quality of the other sorts solely in reference to this selected standard, is clearly the conduct rather of an advocate than of a judge.

2.—Purity of Water.

Water, as conceived of by the chemist, is a definite conpound of 100 parts by weight of oxygen, united with 12·5 parts by weight of hydrogen. So exceedingly difficult is it of production, even if it ever has been produced in an absolutely pure state, that it may be regarded rather as an ideal than a real chemical substance. All natural water, besides the matter, never entirely absent, which it holds in suspension, is a solution of various mineral matters, of various organic matters, and of various gases in the ideal water, or protoxide of hydrogen, of the chemist. Of the different kinds of foreign substance habitually or exceptionally present in natural water, some kinds are beyond question prejudicial, and in particular cases highly prejudicial; most kinds are simply innocuous; while not a few kinds, as saline matter in moderate proportion, and more particularly dissolved aerial matter, are positively beneficial. Looked at, however, from a strictly chemical point of view, any matter whatever foreign to the ideal chemical compound, water, constitutes an impurity of the natural water in which it occurs, whether this foreign matter be a prejudicial or a beneficial constituent, whether it consist of sewage matter,

by which the water is fouled, or of healthful oxygen, by which it is aerated. The chemist uses the word pure, not in the sense of opposite to nasty, but much in the way it is often used in ordinary language, to express the exclusion from one thing of anything else, whether better or worse. Thus, we talk no less familiarly of pure rubbish or pure dross than of pure gold. We speak of pure nonsense as readily as we speak of pure truth, irrespective of the circumstances that the nonsense would be benefited, though to the prejudice of its purity, by its contamination with a few grains of sense. So chemists speak of pure water, irrespective of the circumstance that, for all the needs of life, the water is benefited, though to the prejudice of its chemical purity, by the presence of its dissolved gases, and of a proportion of dissolved saline matter. Chemists, then, are in the habit of using the word "purity" to signify oneness of chemical nature. Accordingly, in the eyes of a chemist, the matter, for example, of an old copper penny would have its degree of purity equally lowered by the same addition made to it of any kind of other matter, whether of base metal, like tin, or of noble metal, like silver, or even gold. Similarly, in the case of natural water, the small proportions of other substance existing together with the main substance, protoxide of hydrogen, interfere with the oneness of its chemical nature; or, in other words, constitute the natural water a mixture of substances, instead of being a single substance, which is alone looked upon by the chemist as a pure substance. It follows, that the water of the chemist is one thing, the water of nature another. The ideal water of the chemist is a single substance; the water of nature, like the air of nature, is a mixture of substances. Just as this last is a variable mixture of the pure chemical substances —nitrogen, oxygen, water vapour, carbonic acid and ammonia, with traces of various other kinds of matter, so is the water of nature a variable mixture of the pure chemical substances—protoxide of hydrogen, common salt, saltpetre, gypsum, limestone, carbonic acid, nitrogen, and oxygen, &c., together with various kinds of organic matter.

Air, from which the minor constituents of atmospheric air have been carefully abstracted, is sometimes spoken of as purified air; but air, deprived in this way of its so-called impurities, is absolutely incapable, in relation alike to animal and vegetable life, of fulfilling the functions of an atmosphere. The substitution of such purified air for actual atmospheric air would mean the cessation on the earth's surface of all life as it now exists. Similarly, with regard to natural water, some of its minor constituents we know to be essential, others of them we have reason to think advantageous to the fulfilment of its functions in nature. Bearing in mind, indeed, the interaction everywhere of life and the conditions of living, we can scarcely doubt that the actual mixed substance, water, is better suited to supply the wants of our daily life, than the ideal unmixed substance would be; and further, we have no reason whatever to look upon this ideal substance as furnishing a standard of excellence, to which it is desirable that our daily supply should, as far as practicable, and in all respects, approximate. What we really desiderate is not chemical purity, but hygienic freedom from anything hurtful. In some water, as in some air, an objectionable constituent may be met with; but in the case neither of water nor air, is there any presumption on the score of wholesomeness, in favour of a single substance as such, rather than of a mixed substance as such. The presumption is indeed the other way. No one desires unmixed oxygen, or even oxygen and nitrogen free from commixture with the minor constituents of our native air; so neither is there any reason to desire unmixed protoxide of hydrogen, freed from the minor constituents of wholesome natural water. It is clearly open to a chemist, addressing himself to chemists, to speak of the constituents of ordinary water, other than protoxide of hydrogen, as impurities in the water; provided of course that he is consistent, and includes the desirable dissolved gases of the water among its impurities and as contributories to the sum total of its impurity. It is also open to a chemist, addressing himself to chemists, to make

a comparison of different natural waters, in respect to the relative proportions of their total impurity, or of their saline impurity, or of their calcareous impurity, or of their organic impurity, or of their aerial impurity, &c. But it is not, I take it, open to a chemist addressing the general public, to speak as a chemist of some particular selected constituent, characteristic of the class of natural waters derived from one kind of source, as an impurity, and to leave it to be inferred by the general public that because this constituent is, in a strict chemical sense, an impurity, it is therefore a something nasty and unwholesome, and that the class of waters in which it is more especially met with are, in proportion to the extent of its presence, nasty and unwholesome. The general public do not know that the chemical impurity of a water may be good or bad, noxious or innoxious, desirable or undesirable, wholesome or unwholesome. They are unaware that no scale of wholesomeness or desirableness can be inferred from a scale of chemical purity, with respect to some particular constituent stigmatised as an impurity, until it has been established by evidence that this particular chemical impurity is of an unwholesome or prejudicial character. It is a mere dialectic artifice, and not a very worthy artifice, to use the word impurity in a strictly scientific sense, with intention to have it accepted in a popular sense as bearing a meaning which, scientifically, by no means belongs to it.

3.—Organic Matter of Water.

The saline matter of water is a useful expression to denote the sum of the dissolved mineral constituents, and the organic matter of water a useful expression to denote the sum of the dissolved organic constituents of natural water. The saline matter of one water is not necessarily, or yet commonly, identical with the saline matter of another water; nor is the saline matter of the selfsame body of water necessarily identical throughout its entire extent, or from one period of time to another. The same holds good with regard to the organic matter of water. It

is a different thing in one water from what it is in another; and may be different in the same water from place to place and from time to time. But just as there is a character or nature more or less common to the usual varieties of dissolved saline matter, so also is there a character or nature common, within certain limits, to the usual varieties of organic matter met with in potable water. So far a certain parallelism holds good between the saline matter of water on the one hand, and its dissolved organic matter on the other. But in many important particulars the parallelism fails. Thus the saline matter occurs, for the most part, in appreciable proportion, say from $\frac{1}{100}$ to $\frac{1}{20}$ of a per cent. It is constituted of definite chemical substances, possessed of well-determined properties; and its amount is capable of estimation with all desirable accuracy—with considerable accuracy by direct weighing, and with yet greater accuracy indirectly, by the separate estimation of its several constituents. The dissolved organic matter of potable water on the other hand, never amounts to more than an exceedingly minute proportion, say from $\frac{1}{5000}$ to $\frac{1}{1000}$ of a per cent.; what are its separate constituents, and what their chemical nature, is almost, if not wholly, unknown; its amount is moreover incapable of direct determination, and the different means for its indirect determination are far from satisfactory. Chemists are capable, however, thanks to Dr. Frankland, of determining with a considerable degree of accuracy, the quantity of carbon that exists in any water, in the form of organic matter. Evidently, if all organic matter contained the same proportion of carbon, a determination of the organic carbon present in any water would be tantamount to a determination of its organic matter. But in reality the proportion of carbon existing in different individual varieties of organic matter has, on the contrary, a very wide range of variation. Still, it would appear, from such imperfect investigations as have been made, that the proportion of carbon existing in the organic matter of water—that is to say, the mean proportion of carbon present in

the whole of the several individual constituents of the organic matter, taken together—is not subject to any such considerable range of variation, and that it may, without risk of serious error, be valued at about 40 per cent. Disregarding then for the moment the consideration of the nature of the dissolved organic matter present in natural water, and confining attention only to its quantity, it may be taken as admitted that the determination of the organic carbon in water is an absolute, and more than fairly accurate determination; that the organic matter of water is in a general way proportionate to the amount of its organic carbon; that the amount of organic matter may accordingly be represented by some multiple of the organic carbon; and that for purposes of comparison, at any rate, this multiple may be taken provisionally at 2·5, corresponding, of course, to the occurrence of 40 per cent. of carbon in the organic matter.

The inquiry next presents itself as to what, on the basis of these propositions, is the quantity of organic carbon, and consequently of organic matter present in the three classes of water derived respectively from each of our typical varieties of source. Speaking generally, it may be said that the proportion of organic matter is decidedly least in spring or well-water—that is to say, if we limit our attention to such waters only as would be taken for town supply, for there are, of course, foul well-waters, in which the amount of organic matter is in excess of anything ordinarily met with in the water of lakes and natural rivers. As between lake sources in general, and river sources in general, it is not easy to assign the order of seriation. The proportion of organic matter found in different lake-waters is, on the whole, more uniform than the proportion found in the waters of different rivers. Accordingly, while in some river-waters the proportion of organic matter is somewhat higher, there are other river-waters in which it is very considerably lower than the proportion commonly present in lake-water. On the whole, it would seem that river-water in general must take precedence of lake-water in

respect to the smallness of its proportion of dissolved organic matter, subject, however, to the observation that the proportion of this constituent is more variable in river-water—that it is liable to a greater range of variation, both as between the water of one river, and the water of another, and as between the water of the same river at different seasons. In order to give some idea of the quantities of organic carbon, and consequently of organic matter, present in the water, furnished from different varieties of source for town supply, I have made an abstract of the results set forth in the Registrar-General's monthly reports for the last year and a half, beginning, that is to say, with the report for January, 1883, and ending with the report last made, for June, 1884, in respect to the supplies of London, Birmingham, and Glasgow. I have resorted to the reports of the Registrar-General in part, because they alone furnish the results of a regular series of analyses of the water supplied to other towns than London; and, in part, because, with regard to London, I have, for the purpose of this address, preferred to bring before you the results of analyses for which I am not in any way responsible. There is not, however, any appreciable difference between the mean results for the period obtained by Dr. Frankland, on the one hand, and by my colleagues and myself on the other, in respect to the composition of the London waters examined by both of us.

The five Thames waterworks companies, as is well known, take their supply from the river at Hampton, Ditton, and Molesey. They furnish just under 50 per cent. of the total supply of the metropolis. The East London Waterworks Company take their supply from the River Lee, some distance below Ware. Their subsiding reservoir at Walthamstow has the enormous area of 222 acres, equal to that of a good-sized lake. The company have power to take in addition ten million gallons of water daily from the Thames at Sudbury. It is but seldom, however, that they resort to the Thames at all; and very rarely indeed to the extent of more than one quarter of the daily amount

they are privileged to obtain. Substantially, the water of the East London Company is water from the Lee. The New River Company take somewhere about four-fifths of their supply from the Lee, above Ware, and the remaining one-fifth from Chadwell springs and a series of deep wells sunk in the chalk. The East London and New River Companies, jointly, furnish about 44 per cent. of the total supply of the metropolis. The Kent Waterworks Company take their water entirely from deep wells in the chalk, and furnish from this source rather more than 6 per cent. of the total supply of the metropolis. The water supplied to the town of Birmingham by the Corporation is taken from various sources, lake or reservoir, stream and well, but in what relative proportions I am unable to say. The water supplied to the town of Glasgow by the Corporation is taken, as is well known, from Loch Katrine. The underneath table shows the actual quantities of organic carbon, expressed both in parts per 100,000 and in grains per gallon, and the estimated quantities of organic matter in grains per gallon, present in these six several supplies of water, as determined by monthly analyses of the waters conducted during the last year and a half.

MEANS OF EIGHTEEN MONTHLY ANALYSES, 1883–84.

Source.	Proprietary.	Organic Carbon.		Organic Matter
		Parts per 100,000.	Grains per gallon.	Grains per gallon (estimated).
Chalk Springs . . .	Kent Company . . .	·047	·033	0·083
River Lee and Springs .	New River Company .	·089	·062	0·156
Mixed	Birmingham Corporation	·132	·093	0·231
River Lee	East London Company .	·139	·098	0·245
Loch Katrine . . .	Glasgow Corporation .	·147	·103	0·257
River Thames . . .	The Five Companies. .	·164	·115	0·286

It will be seen that the organic matter of the Kent Company's water, which is a spring-water, is under one-tenth of a grain per gallon; that the organic matter of the New River Company's water, which is mainly a river-water, is considerably under two-tenths of a grain per gallon; that the organic matter of the East London Company's

water, which is a river-water, that of the Birmingham Corporation's water, which is a mixed water, and that of the Glasgow Corporation's water, which is a lake-water, are alike about two and a-half tenths, *i.e.*, a quarter, of a grain per gallon; while the organic matter of the Thames Companies' supply of river-water is under three-tenths of a grain per gallon. It is to be noted, however, that, although the average proportion of organic matter in the Thames-derived water supplied to London, is a little in excess of that in the Birmingham and Glasgow Corporations' supplies, the excess is entirely due to the effect of the winter floods. Comparing the results in the summer nine months, March to September, 1883, and March to June, 1884, the proportion of organic matter in the Glasgow Corporation's supply is somewhat in excess of the proportion found in the Thames supply, the number of grains of organic matter, being for the Thames derived water ·22 and for the Glasgow water ·25 grain per gallon. Similarly, the organic matter of the East London Company's water, during the summer months, falls appreciably below that of the Glasgow Corporation's supply at the same season of the year,—the season, that is to say, during which a high character of water is considered to be more especially demanded. The above statements, as to the particular fractions of a grain of organic matter ordinarily present in a gallon of different kinds of water, serve to convey some idea of the always exceeding smallness of the quantity. A better notion, however, of the minuteness of even the highest proportions of organic matter found, say, in any London water, is afforded by stating the results in another way. Thus, if we suppose for an instant that the Thames companies' water, instead of containing under three-tenths of a grain, contained seven-tenths of a grain of organic matter per gallon—a maximum which has been occasionally approached in the supply of one or other of the Thames companies at a period of flood—even this exceptional proportion would but correspond to the presence in the water of exactly the thousandth part of one

per cent. of organic water. Whether or not, variations within the limit of such a small proportion of dissolved organic matter present in potable water, ranging from about the one-thousandth part of one per cent. exceptionally met with in a Thames-derived water, down to the eight-thousandth part of one per cent. habitually met with in a chalk-spring water, are matters of any real significance, must obviously depend on the character of the dissolved organic matter present in the different waters. It will suffice for the present to observe that, so far as mere quantity of organic matter is concerned, the water supplied to London from the Thames and Lee takes, on the whole, precedence of the highly reputed, and deservedly reputed, water furnished to Glasgow; as, doubtless, it will take precedence of the water about to be furnished to Manchester.

As regards range of variation, it is noticeable that, while the mean proportion of organic matter present in the summer supply of the Thames Companies, as calculated from the average of forty-five analyses reported to the Registrar-General, is ·22 grain per gallon; and the mean proportion present in the yearly supply, as calculated from the average of ninety analyses, is ·28 grain per gallon; the proportion in one particular sample of water out of the ninety samples analysed, fell to ·17 grain, in two samples it rose to ·50 grain, in one sample to ·53 grain, and in yet another sample to ·60 grain; but that in no one sample out of the ninety did it reach the maximum of ·70 grain per gallon, so as to constitute the thousandth part of 1 per cent. of the water. It happens similarly in nearly all natural waters, that while the absolute variation in the proportion of organic matter present at different times is almost infinitesimally small, the relative variation is, on the other hand, strikingly large. Thus, the proportion of organic matter present in the Glasgow Corporation's lake-water at different times varies as 1 to 2; that in the Kent Company's spring water, in the East London Company's water, and in the Thames Companies' water, varies as 1 to 3 or 3½; that

in the New River Company's water varies as 1 to 4; and that in the Birmingham Corporation's water varies as 1 to 7; but the larger range of variation in the water of these last two supplies is dependent, doubtless, on the circumstance of their being mixed supplies, constituted of unequal proportions of their several contributories at different times. In the official phraseology with which we are so familiar—phraseology of but little meaning, though the words are strong—it would be said that while the degree of "pollution by organic impurity" of the Glasgow water is twice as great at one time as at another, the degree of "pollution by organic impurity" of the Birmingham water is seven times as great at one time as at another. The large extent of relative variation thus noticeable in respect to the organic matter of water, is common, as might be expected, to those other of its constituents, which also exist absolutely in very small quantity, and is, indeed, almost a consequence of the smallness of their absolute quantity. A somewhat parallel comparison may be adduced in the case of personal wealth. We know that while the wealth of a capitalist will, for the most part, vary only by a small percentage from month to month, the whole fortune of a beggar, his utmost riches being a matter of no consideration, may vary manyfold in the course of a day, although by the absolute amount of only a few halfpence put into or taken out of his ragged pocket.

4.—General Considerations.

So far, attention has been directed to the organic matter of potable water, solely from the point of view of its quantity. A much more important inquiry, however, has reference to its nature or quality. But this is too large and important a matter to be taken up at the fag end of an address, limited strictly to the duration of a short half-hour. That the organic matter of potable water is constituted, in the main, of dissolved, unorganised, and non-living matter, does not admit of question. Anything like an adequate discussion, however, of the origin, nature, and possible hygienic

influence of this main portion of the organic matter, could not but involve a very long story. It may suffice here to say that, having regard to its origin and nature, and to the minuteness of its proportion, the presumption against any unwholesomeness attaching to its presence is very strong. To what extent living and organised matter may be also present; how far such living organic matter may include a something capable of developing zymotic disease; and, admitting all this, how far the liability of different waters to contain more or less of noxious living organic matter is related to the varying amounts which they contain of innoxious non-living organic matter, are questions far more difficult of solution. They are questions on which, in the present imperfect state of our knowledge on the subject, it behoves every one to speak with caution; but in my own view, having regard to what is observed and recorded respecting the health of differently supplied populations, and to what little is known of the natural history of disease-producing organisms, the preponderance of evidence does not, I think, favour an alarmful answer. Other persons, however, are of a different opinion. But the address which I have been asked to read at this Conference, is on the chemistry of potable water; and my concern to-day is solely with the chemical aspect of the subject. It is not from biologic or pathogenetic inquiries, but from the results of the chemical analysis of the water supplied to London—from the mere determinations of the quantity of its organic matter—that its wholesomeness is month after month, by suggestion, impugned. On this point I join issue altogether. Further, it seems to me an abuse of chemistry, that a chemist who on other than chemical grounds may, rightly or wrongly, have satisfied himself of the unwholesomeness of a particular water supply, should state and summarise the results of his analyses in such a fashion as to make it appear that the unwholesomeness, which he really infers on other grounds, is deducible from the results of his periodical chemical examinations. It is well understood that a statement, of which the verbal accuracy cannot be

challenged, may, nevertheless, be far from a warrantable statement. It may convey a *suggestio falsi*, and include a *suppressio veri*. Such I take to be the case with the statement, paraded month after month, in what is an official, and should be a scrupulously impartial report, as to the relative "amounts of organic impurity" contained in individual samples of metropolitan water, compared with a particular decennial average amount present in the Kent Company's water,—a standard, by-the-bye, of which the value is known and used only by the reporter, whose comparison, accordingly, it is impossible to check. This monthly statement suggests, I take it, the notion that spring water is the proper type of what river water, or at any rate of what metropolitan water, should be—a notion entirely without foundation, and discordant with the reporter's own strong recommendation of lake-water for the supply of London. It further suggests the notion that the desirableness and general wholesomeness of different waters are inversely proportional to their relative "amounts of organic impurity," irrespective of the origin and nature of this so-called impurity,—a notion equally devoid of foundation. On the other hand, the statement in question suppresses the fact that spring-water, lake-water, and river-water, have each their special characteristics, excellencies, and defects. It suppresses the fact that the so-called "previous sewage contamination" of the standard spring-water is as relatively high, as its "amount of organic impurity" is relatively low. It suppresses the fact that the "amount of organic impurity" in the metropolitan river supply, though threefold or fourfold that present in the spring-water supply, is nevertheless almost infinitesimal in absolute quantity. It suppresses the fact that the "amount of organic impurity" in the highly reputed Loch Katrine supply is, during the summer months, in excess of, and is on the average of the year substantially identical with, the summer yearly amounts respectively present in the metropolitan river supply. It further suppresses the fact that the head waters of the Thames, by the time they reach Lechlade, about 22

miles only from their source, and 120 miles above the Companies' intake have exchanged their character of spring-water for that of river-water, and irrespective of urban contamination, contain an "amount of organic impurity" identical in quantity with, and chemically undistinguishable in kind from, that met with in the river-water at Hampton. I dispute altogether the notion, suggested by the mode of statement adopted in the monthly reports made to the Registrar-General, that the relative unwholesomeness of the Kent Company's water, the New River Company's water, and the Birmingham Corporation's water, was, during the last eighteen months, approximately as the numbers 1, 2, and 3; or, in other words, that it was in the proportion of the 8-hundredths, the 15-hundreths, and the 23-hundreths, of a grain of dissolved organic matter per gallon, present in the three supplies respectively. I contend, further, that the New River Company's water would have been no more wholesome or unwholesome respectively, if, instead of actually containing 15-hundreths of a grain of organic matter per gallon—this organic matter being chiefly of vegetable origin, and a product of ordinary fluviatile life—it had contained, like the Kent Company's water, as little as 8-hundreths of a grain, or like the Birmingham Corporation's water, as much as 23-hundreths of a grain of organic matter, the absolute variations of a tenth of a grain or so of such dissolved organic matter per gallon, being too small to have any real hygienic importance whatever.

If it were indeed the fact that the dissolved organic matter of potable water, taken as a whole, is of such a nature that, in the proportions in which it is met with, it is capable, on occasions, of developing and spreading epidemic disease, it is manifest that no plea, based on the actual smallness of its proportion, would be of any avail to save it from hopeless condemnation. It is manifest also, on this assumption, that the determination of the variations in the proportions of organic matter present in a water, notwithstanding the minuteness of even the maximum proportion,

would be a determination of the highest significance; and further, that any information furnished in intelligible language to the general public, as to the results of a comparison of different waters with one another in regard to their respective proportions of organic matter, would have an extreme degree of interest and value. But all this is based on the hypothesis that the dissolved organic matter of water, or at any rate the dissolved organic matter of some water, taken in its entirety, is a noxious constituent of the water, capable, in proportion to its quantity, of setting up epidemic disease; a view, it need scarcely be said, which is sustained by no sort of evidence, and supported by no weight of authority. If, indeed, the organic matter of water were really of this noxious character, the conclusions above set forth, with regard to the propriety and value of a comparison of waters with one another in respect to so noxious a constituent, would be undeniable. But if, on the other hand, the minute proportion of dissolved organic matter met with in potable water is constituted mainly of innocuous vegetable extractive, with a trace or more of innocuous animal extractive; and if, at the same time, this organic matter does not affect in any appreciable degree the taste, or colour, or appearance of the water, clearly all variations in the amounts present in potable water, that fall within the limits of an exceedingly minute proportion, are matters of no consideration whatever; and this whether they be variations in the proportions existing in different waters, or variations met with in the same water at different times. And the same conclusion would hold good, even if the organic matter of water, while constituted in the main and at most times wholly, of innocuous extractive, was, nevertheless, liable to include at other times a sub-proportion of an effectively noxious agent; unless, indeed, it could be shown that the liability of different waters to contain this noxious agent was in proportion to their relative amounts of dissolved organic matter—a proposition so preposterous as never to have been seriously put forward. Whether or not there exist any good grounds for calling in

question the excellence and wholesomeness of the water, supplied to probably the healthiest great city in the world, is another matter. Speaking as a chemist, I represent that there are no chemical grounds for such a contention. In support of this position, I would call to mind that the last Royal Commission on Water Supply, after hearing very varied evidence, much of it of the usual alarmist character, reported to the effect that the presence of a small quantity of organic matter in drinking water was not necessarily prejudicial ; and that there was not any evidence to satisfy them that the particular organic matter present in filtered Thames water was prejudicial. Their conclusion on the general question is expressed in the following words:— "Having carefully considered all the information we have been able to collect, we see no evidence to lead us to believe that the water now supplied by the companies is not generally good and wholesome."

ON THE PURIFICATION OF WATER BY IRON ON A LARGE SCALE.

By W. ANDERSON, M. Inst.C.E.

In January, 1883, in a paper on the Antwerp Waterworks, read at the Institution of Civil Engineers, I described the application of Professor Bischof's method of filtration, through a mixture of spongy iron and gravel, to the purification of the waters of the River Nethe. The eighteen months' additional experience gained has shown that, so far as the purification of the water is concerned, Professor Bischof's process leaves little to be desired, but the working of the system has been costly, and the area of land required, as well as the quantity of iron necessary has, in the case of the Antwerp water at any rate, proved very much beyond the inventor's expectations.

The increased demands of the town rendered it neces-

sary to extend the arrangements for purifying the water, and it became my duty to advise the directors of the company on the best means of doing this.

The extension of Professor Bischof's method would have involved so great an outlay, that after trying, unsuccessfully, many experiments on direct filtration through unmixed iron at high rates of flow, I determined to adopt a plan first suggested to me, some years ago, by our chairman, Sir Frederick Abel, of agitating the water to be purified with iron instead of attempting to filter it. The object, in either case, was to expose the water as much as possible to an extended surface of iron, consequently any plan by which the iron could be made to keep itself clean by rubbing against itself continually, would seem to be a more rational way of attaining this object, than of trusting to a partial filtration through a more or less spongy material.

The obstacle to trying Sir Frederick Abel's method at a much earlier date, was the belief entertained by Professor Bischof that a contact of about 45 minutes was necessary to ensure complete purification, and any such time would be fatal to mechanical means of performing the work. The late Professor Way, and Mr. Ogston, it is true, had shown that with very finely divided iron the effect was much more rapid, but there was still a doubt about its permanence.

In the autumn of last year, a revolving cylinder, 4 ft. 6 in. in diameter, and 5 ft. 6 in. long, was adapted to try Sir Frederick Abel's system. It was fitted with inlet and outlet pipes, and with shelves or ledges for scooping up the iron, raising it to the top of the cylinder, and then letting it fall through the water.

At first I began to run water through at 12 gallons per minute, which gave a contact of about 45 minutes, but I found that at this rate the water was very heavily charged with iron, I gradually increased the quantity to 30 gallons per minute, and then found that 1·20 grains of iron were dissolved per gallon, or about twelve times more than experience at Antwerp showed to be necessary. The flow

was increased to 60 gallons, and even then 0·9 grains per gallon were dissolved.

The experiment looked so hopeful that I fitted much larger pipes to the apparatus, and having made some other dispositions connected with maintaining a uniform distribution of iron in the cylinder, and preventing it being washed away by the comparatively rapid current that would be possible, I sent the "Revolver," as it came to be called, to Antwerp, where it was put to work at the end of last February, and has continued to operate ever since.

The head available for forcing the water through the "Revolver," is, at Antwerp, limited to 5 feet, but by fitting very large pipes, I have managed to get 166 gallons per minute through; this gives a contact of about 3½ minutes, and is so amply sufficient, that I feel sure that, even for the waters of the Nethe, much less time will be adequate.

The charge of iron is about 500 lbs., and the quantity taken up by the water, including impurities and very fine iron washed away, during a run of 33 days, was 0·176 grain per gallon.

By making suitable arrangements, and choosing a favourable time with respect to the demands of the town, we were able to obtain samples of water that have been purified by the "Revolver" only, and after proper exposure to the air, followed by filtration through one of the large sand filters, the result obtained has been that the colour was very little different from distilled water, the free ammonia was reduced from 0·032 grains per gallon to 0·001, and the albumenoid ammonia from 0·013 grains to 0·0045.

The "Revolver" turns at the rate of about ⅓ revolution per minute, and requires scarcely appreciable power. The area occupied by apparatus for dealing with 2,000,000 gallons per day is 29 feet by 24 feet, and it can be introduced into any existing system of filters, for by enlarging the in and outlet pipes to a suitable diameter, a head of some 12 inches will suffice to pass the water through.

It can easily be arranged so as to be used or not, as the state of the water to be purified may warrant, and the

consumption of iron being only about 20 lb. per million gallons, is quite an insignificant expense. It will be found to remove all colour from water, whether caused by peat or clay, and will facilitate the action of sand filters by the peculiar curdling effect the iron has on the impurities.

During the experiments made at Erith, it was noticed that considerable quantities of gas collected in the upper part of the "Revolver." On collecting this gas, it was found to extinguish a lighted taper instantly, and on analysis was found to contain only 8 per cent. of oxygen.

It was observed from the first, that the animal and vegetable life which was so abundant and troublesome in the natural waters of the Nethe, lying over the spongy iron filters, had quite disappeared in the water, otherwise in exactly the same circumstances lying over the sand filters, and I always supposed that this was due chiefly to mechanical filtration through the spongy iron having separated all the germs, spores, and seeds which come to life above it. But during the recent hot weather it has been found that the water from the "Revolver," though it contains all the impurities of the natural water, has been modified by the action of iron to such an extent that neither animal nor vegetable life is apparent over the sand filters. Without presuming to draw very wide inferences from this fact with reference to the action of iron upon organisms connected with disease, it may, at least, be pointed out that the absence of visible life in water treated by iron on a large scale confirms, in a great measure, the experiments of Dr. Frankland, Dr. Voëlcker, Mr. Hatton, Professor Bischof, and others. It is due to the last named gentleman to state that to his persistent advocacy the introduction of iron as a purifier is mainly due. It must be borne in mind that the system does not depend on filtration only, but, first, on a process of exposure to iron, which decomposes the organic matter, and kills living organisms; and, secondly, on simple filtration, which merely separates the noxious matters which had been previously attacked by the iron. The waters of the Nethe are exceptionally bad,

and heavily charged with impurities, so that the test both of Professor Bischof's and Sir Frederick Abel's systems has been very severe.

DISCUSSION.

Mr. W. S. MITCHELL, wished to make a remark or two with reference to Mr. Sorby's paper. The difficulty had always been to get small spores in such a form that they could be seen, but a plan had now been adopted to cultivate these spores, and in the Exhibition there were two methods shown of doing this. One at No. 193 in the Central Avenue, exhibited by Messrs. Nicholson and Mr. Carpenter, and the other in the Physiological Laboratory, where Dr. Koch's method was exhibited, which consisted of cultivation in a gelatine mixture, a kind of solid soup, and that was under the charge of Mr. Watson Cheyne. A plate of glass was taken on which some of this mixture was spread; on this a single drop of water was placed, which was then covered with glass, so that no matter from the air could reach the surface, and then the spores were allowed to grow. Some could now be seen which had been growing for fifteen or sixteen days. This method had been carried out, he understood, in Berlin for two years, but this was the first time it had been shown in this country.

Mr. JABEZ HOGG wished to say, in reference to certain remarks which had fallen from the Chairman, that he had no intention of defending the conditions of London cisterns in general, and that his remarks of yesterday applied strictly to well-covered house cisterns: he had always acknowledged that pollution must take place in uncovered tanks. He might add that in the evidence he gave at the Kingston inquiry, he stated that the small fish and eels, and other unwholesome things found in some cisterns, could not have spontaneously bred there. With regard to

the paper just read, he should have been glad indeed if he could say he agreed with Dr. Odling's conclusions. The meeting, however, would have been in a much better position to discuss his conclusions if they had been put in print, and he was sorry that this had not been done, as they were in fact, the most important part of the paper. He was so far in accord with him that purity, as expressed by chemists, had a very different meaning to that attached to it by the public, and he hoped Dr. Odling would, in future, say that they must not take the purity of the water as he set it forth in his reports, to mean absolute purity and freedom from unwholesome conditions, that is from organic germs, freedom from what medical men knew to be deleterious to human life. Dr. Odling had said that the pure water of the Kent Company contained more organic matter than the water of the Thames; this appeared to be a fiction—a chemical fiction; and Professor Frankland, who originated the previous sewage contamination theory, now put it aside, and told them it had no value whatever; in fact, it had so little value, that it merely expressed something that chemists understood, and the public did not. The public were not in a fair condition to say what the chemist meant, but they know what they wanted, they wanted water perfectly free from all organic impurities, and if they got that, they cared little whether it was one grain or a dozen grains of mineral matter to a gallon. The one grain, however, which some chemists despised, was more than sufficient if it contained a specific germ, as that of typhoid fever or cholera, to poison a whole town of 40,000 inhabitants. What more did chemists require in the way of impurity? Chemists could tell us of the impurity of water; but they could not assure us of purity and safety. Chemistry could not detect the millionth, or trillionth, part of a grain of deadly organic matter in a gallon of water. That being so, it showed that chemists could only very imperfectly perform the duties undertaken by them; they could not protect the public health, as they had sometimes been led to assert. Dr. Odling had referred to the

Registrar-General's reports of June; but he had in his hand later reports, those of July, also issued from Somerset-house, and with regard to three or four towns supplied with deep well water, he noticed that Brighton had a death-rate of 13·9 to the 1000; Hull 19 to the 1000; Portsmouth 14·1 to the 1000; whilst London had 24 to the 1000. That showed that there was a considerable difference in the death-rate of towns supplied with pure and wholesome water, such as he held deep well-water to be. In London with the rise in temperature, during the month of July, there was a corresponding rise in the deaths from diarrhœa and dysentery; there were 39 in the first week, then 104 in the next, and 336 in the succeeding week. In the next month they rose again to 533, exceeding the corrected average by 242—435 were of infants under one year of age, and 78 of children between one to five. There was usually a considerable difference in the death-rate whenever the temperature of water ranged above 60 degrees, then it was that the danger of an impure drinking water was greater. He had placed on the table two specimens of deep well-water from Canterbury, one taken before being submitted to a softening process, the other after it had been softened by Clark's process. The deposit thrown down he had examined under the microscope, and could find no trace of organic matter, not even a diatomaceous body, which he expected to find under a high power.

MR. EDWIN CHADWICK, C.B., said the chemical tests for water omitted altogether what was called the biological, or stomach test, of which he might give a remarkable instance—that was that there was a change in the supply of water of the Millbank Prison from the Thames, which had formerly been used, to that of the well at Trafalgar-square, and there was a return by the medical officer of the prison, in which he showed the difference produced in the population by this change. The evidence of the benefit resulting from the change was perfectly overwhelming. In Glasgow, Aberdeen, and Manchester, all the water was

found to produce dyspepsia, which chemists did not detect or take account of, but it was perfectly decisive as to the quality of water, especially during particular portions of the year. He thought it would be well if the investigation as to the sanitary results were pursued by asking the officers of prisons to note the difference produced in the health of the prisoners by a change of water; those who have been for a time in a hard-water district, and those who were in a soft-water district, and he had no doubt that result would be obtained similar to those recorded in the instance he had referred to at Millbank, and which were utterly unnoticed by any chemist at present. Again, the Chairman would know very well how the quality of water depended on its aëration. At Pangbourne you might take up water, and find it quite brilliant, showing evidence of good quality, but when that same water was taken to London, and put into a cistern where it came in contact with the air of the cistern, your were really drinking down air with all the impurities which were likely to arise. In going into overcrowded rooms, or low neighbourhoods, medical officers would tell you that in washing, after an operation, their fingers quite smelt of the water they obtained there. He recollected on one occasion, when making an inspection in Rotherhithe, the medical officer cautioned him against taking any water there, for it would be dangerous, because the water beds were situated close by the cesspools and absorbed the cesspool air. Some years ago, he asked Dr. Hofmann if he could analyse a London fog, which carried disease with it; but he could only separate the dust and dirt, and he failed to analyse them. Again, with respect to the paper which spoke of the protection of rivers by the action of plants, he would point out the immense difference between fresh sewage and that which was putrid. When the houses of a town were drained, or water-closetted, so that the sewage discharged fresh, it was noticed that fish returned to the river which they had forsaken. That had been noticed at Carlisle—the fish reappeared, and were finer in quality altogether.

Mr. BISCHOF said it had been a point of the greatest interest to him to learn that spongy iron, after a very few minutes' contact, had such a powerful effect in destroying animal and vegetable life. Mr. Anderson had said that his anticipations at Antwerp were not quite fulfilled, and that was quite true; but he never anticipated the difficulty which had been experienced there. To deal with a small tidal river contaminated with all kinds of polluting matter, and to convert such water into a potable water, every one would admit was a matter of the greatest difficulty. However, the plan introduced by him had been styled a "complete success" by the Chairman of the Antwerp Waterworks Company, at the last general meeting. Dr. Odling had been speaking under great difficulties as regards time, no doubt; but to him, as a chemist, it would have been of much interest if he could have given some hint as to how he arrived at the statement that organic matter in water might be said roughly to contain 40 per cent. of organic carbon. As a chemist, he could scarcely conceive that there should not be an enormous difference in different organic matter, because some water was contaminated largely—in fact, almost exclusively—by animal and other water by vegetable matter, and they all knew that animal and vegetable matter differed very greatly in the proportion of carbon they contained. He wished to refer to only one more point. He had in his hand the return of the Registrar-General for July 20th, 1878, which stated:—"The weekly deaths from diarrhœa and simple cholera, which had been 23, rose to 78, 156, 256, and 349 in the corresponding weeks. The deaths from diarrhœa are differently distributed in the fields of the water companies. Thus, the deaths in the last four weeks were 786 in the districts supplied with the Thames and Lea waters, whereas the deaths in the districts supplied with water drawn from the chalk by the Kent Company were 19; but of the same population, the deaths in the former were to the deaths in the latter as 3 to 1." As there might be a visitation of cholera this autumn, and as they all agreed

that diarrhœa and simple cholera, although totally distinct from Asiatic cholera would still predispose to it, this was a point of very great interest, and he should be glad if Dr. Odling, or any one else, would express an opinion whether these figures which he had just read did not throw an important light on the relative wholesomeness of the different supplies of water to the metropolis.

Dr. BARTLETT said, one observation made by Dr. Odling very naturally led up to the few words he had to say. He stated that certain water, when thoroughly filtered, would then be good enough, and pure enough, for all potable purposes; another leading observation was made in Mr. Anderson's paper, namely that by mixing iron in a very finely powdered state with water, a far greater efficacy was obtained than can be in the ordinary way, by passing it through coarse filter beds or compressed blocks of porous iron or other filtering substances. He so far cordially agreed with that statement that it formed the very pith of what he wished to say. At the present time the question of filtration, whether in the water companies' sand-beds, or in the domestic filters which persons now used for the purpose of correcting any omissions on the part of the companies, was highly prominent. One section of the public appeared to rely entirely on this process, and another semi-scientific section were apt to place no reliance whatever on it. It had been stated, over and over again, that filtration could not remove matters in solution, but only those in suspension; but to that statement he took objection, because during the last ten or fifteen years, in the process of testing a great number of filters—in fact, almost every kind which was presented to the public—he had found, that to a lesser or greater degree, nitrogenous matters in solution were removed. The manufacture of filters, and the scientific application of filtering media, had improved, but although he said this with great confidence that there were filters which would remove nine-tenths of the nitrogenous matters in solution, still, he was equally certain that nine-tenths of the filters before the public were perfectly worthless, because with

the tenth part of nitrogenous matter which was not removed there was that amount of unfiltered water passing through into the storage receptacle. Now, if the tenth which passed through contained any of the germs of disease, or communicable matter of disease, whether germs or not, that would be equally as fatal to the drinkers as if it were entirely unfiltered water. He had been led to this train of reasoning more particularly because during the last six or eight months he had been testing filters which removed nine-tenths of the decomposible organic matter; and the other tenth would have been removed had the filters been mechanically perfect. He had been making experiments on a very fine precipitate, sulphate of barium, and found that that freely passed through many of the filters, and therefore it became obvious that matters which were very much smaller than that would equally pass through. He then went on with salts of uranium, a still finer precipitate, and found they almost invariably went through. Then it occurred to him it would be well to try if he could not stop this. Both these salts were white, and, therefore, were perfectly visible to the naked eye, or, in the finer particles, under the microscope. He tried to stop it by using finely powdered carbon, animal, vegetable, and mineral. The result was that he found that with carbon of all three kinds, when reduced to much finer particles, they also came through the greater part of the filters he tested with it. This was most important, because anyone could go home and make similar experiments for himself. In working this out, he found after having used a considerable amount of very fine carbon, he had stopped very nearly the whole of that one-tenth of decomposible matter, and in fact he had decomposed the greater part of that tenth. Knowing the oxydising influence of spongy platinum, he went one step further, and used platinum black. Of course he would not recommend this as being suitable for ordinary filtering purposes, because of its expense, and there might be other objections also; but it did absolutely oxydise and remove every trace of decomposing nitrogenous matter.

That being the case, it was certain that perfect filtration could be obtained. Following this up, he had tried carbon in the finest divided state, so fine that he found by the microscope the particles were finer than the markings on a diatom, for under a 50th power he could not measure them, although he could measure the markings of diatoms. Carbon, therefore, could be obtained, if necessary, in so fine a form of sub-division that an immense amount of oxydising power was thereby obtained. It might be said, how were you going to filter water through that extremely finely divided carbon. He thought possibly that cotton wool, which obstructed all germinal matter passing through, as was shown in the well-known experiments of Professor Tyndall and M. Pasteur, was a means to the end, but soon afterwards he found that cotton wool decomposed in water, and therefore that upset the experiment. He therefore tried two other media, one a peculiar kind of slag wool, and the other asbestos fibre, both of those retained the finest particles of charcoal, and formed a perfect filtering medium as far as developing the oxydising property of finely divided carbon was concerned. Having obtained this result, he must add that he was not aware of any filter now before the public which had no decomposing matter in its construction. The introduction of the cork caused decomposing matter to be mixed with the water, and under the microscope large quantities of moving organisms were to be found in the decomposing matter of the cork itself. The same thing, in a lesser degree, occurred with india-rubber, and, therefore, he laid it down as a fundamental axiom in filter-making that no decomposing matter of any kind should enter into its construction. Further than that, the filtering media should neither pass the finest possible charcoal, nor should they be choked up by it. These two points formed the most important tests he had to bring forward. If they fell back on the old plan of testing filters which we had been in the habit of using for twenty years, they would be misled as to the mechanical deficiencies of which he had spoken of, for it was no use whether one

adopted Dr. Frankland's process for the analysis of water, or the estimation of ammonia, to suppose that because you were able to oxydise three-quarters, or even nine-tenths of the decomposible nitrogenous matter, that the filter itself was therefore of any value. If this were recognised, and people would make the experiment for themselves, he believed better filters would be produced, as purchasers would be able to test the filters by these means. There would be at last a possibility of arresting much of that which was injurious to health; and it was not impossible that they might prevent even the smallest germs, which must be of some size, passing through the very fine medium he had suggested.

Mr. THOMAS SPENCER said they had heard a great deal of the necessity of softening water, and a great many processes for effecting that purpose had been mentioned, but they had heard nothing as to the physiological difference to the animal system of very hard water and very soft water. For forty years he had been going through most of the towns in England, and he could never get that question answered—what was the physiological effect on the system of hard water, as hard as that supplied by the Thames, as compared with soft. He might say that he knew most of the water supplies of the world, and he did not know of a better supply anywhere than that which came from the Thames when properly filtered; he did not mean by any chemical means, but when well filtered mechanically. He had constructed waterworks at Calcutta, and knew many of those on the Continent, and if the Thames water were well filtered, it would be one of the best water supplies to any large town in the kingdom. When he put that question he never got a reply, but was told he did not require any explanation—that salts of lime and magnesia were not desirable. Two years ago, he suggested to the authorities of a town with which he was connected, that to settle this question it would be well to get accounts from the authorities of the different towns, and ascertain where the death-rate was highest—whether

in towns having a soft water supply, or hard water. That report had now been returned, and no doubt would be in print before long, when it would be found that the death-rate was larger where soft water was used, and this to a much greater extent than he had anticipated. He must say also that he began as a soft water fanatic, but there was no doubt that one reason why soft water was so much recommended was that in many of the towns in the north, calico-printing, and similar works were very numerous, and as soft water was much better for such operations, people naturally supposed that similar water was better for domestic purposes.

Mr. MAIGNEN said he had hoped some paper would have been read on the subject of filtration as a whole. They heard a good deal of how water was contaminated in a very astonishing way, but how to get over the difficulty they had heard very little. He could not attempt to do justice to the matter in the very few minutes he had at his disposal; but what he had to draw attention to was this, that on Thursday last he was in the laboratory of M. Pasteur in Paris, who asked him "how will your filter last?" Now this was a subject worthy a whole day's discussion. The first necessity of filtration was that, when impurities had been collected in the filtering material, it could be easily removed, and thrown away and replaced. Dr. Bartlett had knocked the nail on the head by drawing attention to a very important fact. If a microbe had a body, it was just possible to conceive an impediment, or a series of impedimenta, fine enough to prevent it passing through. Dr. Bartlett told them that he had used charcoal the particles of which were smaller than the smallest known diatom, and if these particles did not come through a particular form of filter, it was conclusive that the diatom itself could not pass through. He echoed the statement made by one of the speakers, that if the London Thames water were properly filtered, it would be the best in the world, and he had reason to hope that this would soon be attained by means of the apparatus shown on the wall.

Dr. HAUGHTON said a great deal had been said in favour of the water they were obliged to drink in London, there being no option as to the source from which it was obtained; and he wished he could heartily endorse all that had been said in its favour, because it was unpleasant to have a bad opinion of that which one had to deal with continually. He listened to Dr. Odling's paper with great admiration until he came to the last sentence; but they were not told there whether his estimate of the London water as compared with the supplies of other towns was founded on its present condition, or on some former period, or on a fair average. He had in his hand an extract referring to the condition of things at the time of the epidemic of 1830; but it was written twenty years later, and those periods were not referred to with reference to the microscopical analyses and examination of the water. It stated that at this time there was hardly a water company in London the water of which did not reveal to the microscope solid particles of sewage floating about in the company of small weeds and sponges, and fine fat pulpy animalcules. At an interval of twenty years there was the same condition; and it was obvious that when such things had happened they might happen again, especially when eels and fish were found in reservoirs where they were not bred. It was not at all infrequent in disputed cases in the Law Courts for chemists to give evidence with regard to the supposed condition of streams; when one would state that the water was dirty, and another would say it was beautiful, and both had made analyses, and both were men of science. With regard to the basis on which this statement with regard to London water was founded, it appeared, so far as he could make out, that the ground upon which Dr. Odling claimed this wonderful excellence was the very ground which, in the earlier part of the paper, he said it was totally inapplicable to put before the general public. For if he only got the chemist's estimate of the amount of organic matter, and that was put forth to the general public as a test for the

quality of the water in order to re-assure the said public that the water they were drinking was beautiful, they found Dr. Odling himself saying that it was not a reliable test. Yet at the end of the paper he said London water was very superior because of this very thing, for he brought no other evidence. That appeared to his mind very unsatisfactory, speaking not as a medical man, but as one of the long suffering public who had to drink water which had been testified to be contaminated, not far from the intake of the companies, with organic matter of the foulest description. It was true those cases were not very flagrant, except at particular periods, but they wanted a guarantee that they should not occur at all. What was the use of talking about filters, and telling the public the water was unfit to drink unless it were filtered. It was the grossest cruelty to the poor. They could not buy filters, and even if they were distributed gratuitously, there was not one family in ten who would take care of them, so as to see them renewed. You might filter out the cats and dogs, and the grosser particles of matter; but the better the filter the sooner it became filled with germs, and every kind of contamination. It was the very nature of a filter to become filled with foulness, to breed microbes, to become itself a source for contaminating the water, if it were not renewed within a reasonable time. The gentlemen who spoke so much in favour of filtration had an idea, which was good in itself, that the filtering medium should be so arranged as that it could be renewed; but to say that the general public were to depend on any kind of filter, patent or not, was stark nonsense. This evil was not imaginary, for it was given in evidence before the Metropolitan Medical Commission in 1830, that whenever water was contaminated so as to be nauseous, diarrhœa was invariably prevalent, and affected the health of every person drinking it. He did not want to increase the cholera scare, but he hoped to utilise it, by demanding of the authorities that no money should be spared to give a good supply of water, which should be available for every house in the city,

without putting a single inhabitant to the expense of a filter.

Dr. ODLING, in reply, said he had been invited to read a paper on the chemistry of water, and had, therefore, confined himself mainly to chemistry ; and for this, under the circumstances, he did not think he was to blame. At the same time he might say that for many years he was a medical officer of health, and had since attended to hygienic studies, and he came prepared to speak not only as a chemist, but also as a physician and hygeist. As regarded the general question, the influence of the presence of organic matter in water must depend, not on its quantity, but its nature. And any comparisons put forward with regard to quantity, irrespective of nature, fell to the ground altogether. Had there been sufficient time, it was his intention to discuss the question of quality as he had the question of quantity ; and he had notes ready for the purpose, but time did not allow of their use. Any general statement, and any conclusion he had formed or expressed, with regard to quality, was formed on a consideration of evidence, and was gone into by him as minutely as he had gone into the question of the influence of quantity. The gist of the whole question in the present state of knowledge seemed to rest on an observation of effects. Of course if you took one week and compared it with another, or one town with another for a short period, you might arrive at almost any result you pleased ; but if you took large populations, and examined the statistics for lengthened periods, it would be found that there was absolutely no difference whatever in the health of the population which could be ascribed to the drinking of river water, or spring water ; from which it would seem all these different varieties were, in their different ways, well suited for the supply of large populations.

III.—METHODS OF DISTRIBUTION. MODES OF GIVING PRESSURE, HOUSE FITTINGS, DISCOVERY AND PREVENTION OF WASTE, ETC.

WATER DISTRIBUTION AND DUAL SUPPLY.

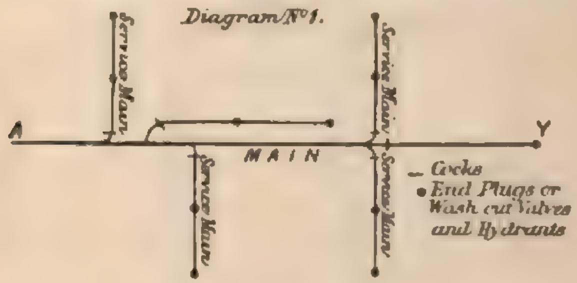
By Col. Sir FRANCIS BOLTON.

In former times it was customary to lead water through aqueducts to public fountains, whence it was taken by water carriers to those consumers who could afford to pay for it, while the poorer classes fetched the water from the fountains for themselves; and this system still exists in certain large cities abroad, such as Constantinople and Venice. In some towns, indeed, even in ancient times, this primitive mode of delivering water was found insufficient for the better class of houses. In luxurious Pompeii, for instance, which was destroyed A.D. 79, a very complete system of distribution appears to have existed by means of pipes, which delivered the water direct to the houses. This mode, however, was by no means general, the inhabitants of most cities contenting themselves, as above mentioned, with the services of water carriers.

A very noticeable want in connection with those towns which derive their water supply from public fountains is that they are, for the most part, without any sewage system, and the evils arising from this serious drawback may be readily imagined, although it is not the object of this paper to describe them. On the other hand, it should be mentioned that the difficulty of carrying large quantities of water in such

towns to the houses separately has, from time immemorial, been remedied to a certain extent by the construction of public baths, and other public conveniences for the general health and benefit of the inhabitants.

The mode of distribution which may now be said to be almost universal is by means of cast-iron pipes, and as far as our knowledge goes, in the present state of hydraulic engineering, this system may be considered perfect. Towns are divided into districts, according to position and level, and in each district mains are laid, usually following the course of the principal streets. From these mains service pipes supply all the streets within the area. Each service pipe is provided with a cock at the junction with the main, and a wash-out valve at the other end, fire-plugs



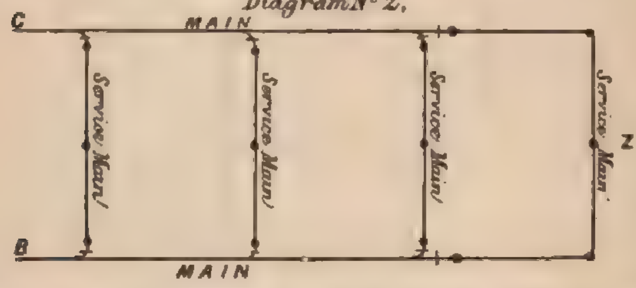
or hydrants being inserted at convenient distances, usually about 100 yards apart. In those districts which are supplied on the intermittent system, the service-pipe cocks are opened and closed at certain intervals; but where the plan of "constant supply" is adopted, they are always left open, except in case of accident, or during repairs.

On reference to Diagram No. 1, showing part of distributory mains on this system, it will be seen that the water, on entering the service pipes, enters as it were a *cul de sac*, where, unless there is a large draught or consumption, it is apt to remain practically stagnant, thus allowing the impurities held in suspension to be deposited on the sides and bottoms of the pipes. It is for this reason a wash-out valve is placed at the end, which, if opened

sufficiently often, allows the impurities to be washed out; but if this precaution is neglected, the impurities accumulate, and when a sudden call is made on the service pipe, find their way to the consumer.

By having no "dead ends," as shown in Diagram No. 2, this difficulty is obviated, as the water is continually circulating in all directions. This arrangement is of great advantage where there is constant supply, as in case of accident at C, the main, B, would supply the service pipes entirely whereas if an accident occurred at A (Diagram No. 1), the whole district beyond would be without water until the repairs were completed. It has the further advantage that should a fire occur at Z (Diagram No. 2), both mains, B and C, would supply that and the adjoining hydrants, whereas

Diagram No 2.

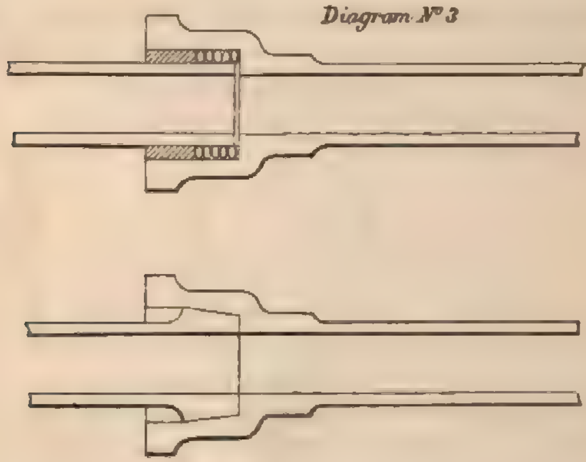


a fire occurring at Y (Diagram 1), would only have the water passing through the one pipe. Equal facilities occur for washing out the service pipes, if found necessary, by closing the cock and opening the adjoining hydrant.

The pipes should be of iron, of good tough quality, as, if the metal is brittle, difficulty is found in cutting the holes to receive the house service pipes; 2 inch pipes are usually cast in 6 feet lengths, 3 inch to 12 inch, 9 feet length, and 12 inch, and upwards, in 12 feet lengths. In order to ensure uniform thickness, the pipes are generally cast upright, and socket downwards; and to prevent oxidation of the interior, they generally either receive a coating of lime inside, or are dipped whilst hot into a mixture of pitch, oil, and tar, which is usually known, from the name of the inventor, as

Dr. Angus Smith's composition. The protection of the interior of the pipe is particularly necessary if iron is used in the filtering medium, as otherwise the water becomes distinctly chalybeate if the consumption is slow.

The mode of connecting the pipes together is by slipping the spigot end of one pipe into the socket of the next, and then making the joint. Diagram No. 3 shows the ordinary method of joining pipes. No. 1 is the ordinary "yarn and lead" joint, and No. 2 the "turned and bored" joint. In No. 1 the best white yarn is caulked in to a depth of about 2½ inches, and the rest of the space run in with soft lead,

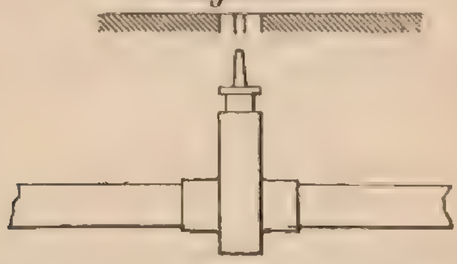


which is afterwards well set up or caulked one-eighth of an inch within the rim of the socket. The chief point to be observed is that no part of the yarn should find its way into the interior of the pipe. In No. 2, the turned spigot is simply brushed with cement or paint, and pushed home into the bored socket. The extra space is sometimes run with lead and sometimes left. The most approved modern system is to run the joint solid with lead without the yarn, a strip of drawn lead being inserted in the bottom of the socket in lieu of yarn.

For connecting the service mains suitable cast-iron

branches are introduced. The cocks used for regulating the flow of the water consist of a door, which is raised or lowered by means of a screw worked from the surface, as shown in Diagram No. 4. For the purpose of supplying water in case of fire or other emergency, openings are left in the mains, which are closed in some old waterworks by wooden plugs, but in all recently constructed ones by hydrants, which are undoubtedly to be preferred. The description of these, however, properly belongs to the section treating of the supply of water for extinguishing fires, and a full account of the various forms in use will be found in the special paper on "Water Supply for Fire Extinction," by Mr. J. H. Greathead, C.E.

Diagram No. 4.



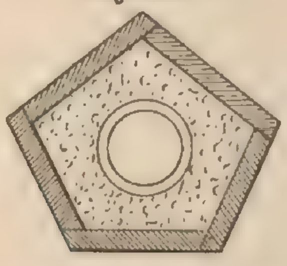
Each house is connected with the service pipe or main, by a pipe called the "house-service pipe," the connection being made by means of a ferrule screwed into the main. The house-service pipe is generally of lead, but as some waters have a chemical action upon this metal, drawn-iron pipes, either glazed, galvanised, or otherwise protected, are substituted. Where the system of "constant supply" prevails, an apparatus is used in order to avoid inconveniencing the consumer, which enables the ferrules to be inserted while the main is still charged and under pressure.

The depth at which mains should be laid varies according to circumstances, but may be taken in temperate climates to be from two to three feet from the surface of the ground to the top of the pipe. In colder climates the mains should be laid at sufficient depth to escape the action of frost,

which, generally speaking, does not extend below four to five feet. When mains are laid at this depth, the cost of laying as well as making house connections and effecting repairs is considerably increased. When the temperature of the water varies considerably at different seasons, the length of main is affected. Where "socket joints" are used, little damage is done, but with "turned and bored joints" it will generally be found in autumn that some tightening up of the joints is necessary, unless special provision is made for the contraction that then takes place.

Where pipes are carried across openings they should be protected from the changes of temperature, which can conveniently be done as shown in Diagram No. 5, in which the pipe is shown enclosed in a wooden casing, the circular

Diagram No 5



space being filled in with felt, sawdust, or other non-conducting material. In laying mains across bridges, great care should be taken for their protection. It will often be found that there is not sufficient depth from the surface to the arch or girder of the bridge to allow of the pipes being laid; when this is the case, it is convenient to carry the mains on cantilevers at the side of the bridge, the pipes being enclosed in a casing of wood or other material, as shown in Diagram No. 5. In new bridges it is generally arranged to leave sufficient space for a subway below the footpaths; this, as a rule, is a very convenient way, as it allows of repairs being effected without interfering with the ordinary traffic.

The system of distribution hereinbefore described refers

mostly to the distributing pipes within the town. In some exceptional cases, owing to local circumstances, wooden pipes, similar to those which were used before the introduction of iron pipes, are still used, and in places where freight and carriage are difficult, pipes formed of sheet iron or steel can, owing to their lightness, be more economically used than those of cast iron. Pipes have been made of paper prepared with bitumen and several other substances, but have not been proved able to withstand the severe tests to which water pipes are subject. Where the pressure is very great, as for instance where water is distributed for hydraulic power, the pipes are cast of extra thickness, and a "faced" flange joint with an india-rubber ring inside a recess, into which a projection on the next pipe fits, is sometimes substituted for the socket joint.

The construction of the aqueduct conveying the water from the source to the distributary mains varies with circumstances. If the water is conveyed under pressure, one of iron is necessary, and preferably of cast-iron, which, being laid under the surface of the ground, is better in all respects (apart from cost) than any other. The pipes are so placed as to follow pretty closely the undulations of the ground, an emptying valve being fixed at the bottom of every fall, and an air escape valve at every summit. When large quantities of water, however, have to be conveyed, aqueducts of masonry, brickwork, or concrete, have to be adopted. These, unlike pipes which can be made to follow the inequalities of the ground, have to be laid to a regular gradient. Provision is made for draining such aqueducts, and overflows are placed along their length to prevent damage in case of the flow of water being interrupted. All aqueducts of masonry, &c., should be covered, but this is not always possible when they are of large size. Size, indeed, renders the covering less necessary, provided precautions are taken to prevent the infiltration of land drainage, as the large quantity of water flowing down is less liable to be affected by the sun, while the conduit, being uncovered, can be easily and completely cleansed at all times.

The cross section varies with the materials employed; those of brickwork and concrete being generally of an oval or circular form, whilst those of masonry are usually constructed with a rectangular section, and when covered, are sometimes arched over, and sometimes covered with slabs. For the aqueducts, tunnels often have to be made through hills, and conduits over valleys. These latter, when there is sufficient head of water available, are usually crossed by syphons of cast-iron pipes. When, however, the head of water cannot be spared, the aqueduct is carried across the valley at the regular gradient, and supported by piers of masonry, or other suitable material. In this case, the aqueduct is sometimes continued in masonry, brickwork, or concrete, or a trough or tube of wrought iron is substituted. This trough is sometimes made of pipes of sheet iron or steel, riveted together throughout the full length of the crossing, and suspended and braced by wire cables or rods, similarly to a suspension bridge.

One of the most important of modern aqueducts is that bringing the water of the River Vanne to Paris, the length of which is about 90 miles, with 23 syphons of wrought-iron pipes.

The chief points to be observed in the designing of a complete distribution should be—(*a*) that the water, which before entering the mains is in its purest state, should be delivered to the consumer in a similar state, and suffer no contamination on the way; (*b*) that the mains should be of sufficient area to allow an ample quantity of water to pass to meet all contingencies; and (*c*) that a constant circulation should be maintained of about 3 ft. per second so as to prevent any deposit taking place.

Dual Supply.

In the case of many large towns, an abundant supply of water of inferior quality is found in close proximity, while further off, but still within reasonable distance, a limited supply of better water exists. In considering such cases, it often becomes a question as to the advisability of adopt-

ing both sources of supply, the latter for drinking purposes, and the former for domestic and manufacturing uses. In the opinion of the writer, a system of dual supply is not practicable for domestic purposes, but only for municipal or manufacturing requirements. In cases where water is used for power, a dual supply may also be considered indispensable, as the great pressure necessary for its economical use for this purpose is undesirable for a domestic supply. Again, a separate supply for municipal purposes can be used for road watering, sewer flushing, fires, &c., without affecting the domestic supply. In most manufacturing towns the factories are grouped together, and require large quantities of water at a very cheap rate, which, supposing the water is not used in any way for alimentary purposes, can often be supplied from sources sufficiently pure for purposes of manufacture, although the water may be unfitted for household consumption. Such a supply exists at Roubaix, in France, where the cheapness of the water contributes to the prosperity of the town.

Paris also is supplied in the same manner, there being a double set of mains in the streets, one for domestic purposes, and the other for street watering, &c. The supply of potable water, however, is limited, and in time of drought has to be supplemented by water drawn from the Seine.

A dual supply for domestic purposes would entail a considerable extra outlay on the construction of works, as a double line of mains would be necessary in every street, and the cost of most of the house fittings would be doubled, as they would have to be in duplicate. Another objection is the probability that the excellent quality of the water supplied for potable purposes would cause the quality of the other to be little considered, and the latter might deteriorate, or become subject to great contamination. Consumers, bearing this in mind, would probably use the purer water almost entirely. In ordinary times, this might not be of much consequence, but in times of drought it might be serious. This difficulty, it is reported, has just

occurred in Paris, which, as just stated, is supplied under this system, and where now, in the heat of summer, with the cholera possibly approaching the town, the drinking water is said to be failing, so that nearly all the supply will have to be taken from the other source, the Seine. Unfortunately, this water is not as carefully filtered and aërated as it would be if it were usually used for domestic purposes, and it may consequently prove a source of danger and disease.

When only one supply exists for domestic purposes, means are generally taken to render it as pure as possible, either by efficient filtration, or by such other means as may be found necessary. Should such water not be considered of a sufficiently high standard of quality, a pure source is selected, and the old one abandoned; when this is impossible, the use of household filters becomes universal.

When the Chelsea Water Company first moved their intake to Ditton, in carrying out the works an extra reservoir was constructed, and extra mains were laid for supplying unfiltered water for road watering and other purposes, but in practice this arrangement was found to be no saving, and to possess no advantage over supplying filtered water for these purposes, so it was discontinued, and now none but filtered water is supplied.

It may be contended that if water were sold by meter, the difficulty of supplying the two kinds of water for domestic purposes would be overcome, inasmuch as the extra cost of the purer water would prevent its excessive use, and so conduce to its conservation and the greater use of the inferior water. This argument, probably, would prove fallacious, as the servants who use the water are unaffected by any such considerations.

It might, further, be urged that the inferior water should only be laid on to the closets, and that the supply to them should be independent of the general domestic supply. This arrangement would leave the remainder of the domestic supply to be furnished by the better water. Baths even would have to be supplied from it, for when it

is remembered that they are very frequently supplied with hot water from an apparatus from which water is drawn for other purposes, it will be seen that it would be practicably impossible for them to be connected with an inferior supply. Apart from special cases, in which water is distributed under great pressure for power, and under smaller pressure for ordinary consumption, only one plan of dual supply seems feasible, which, however, from the necessity for duplicate mains, &c., must necessarily be costly, though it might prove advantageous in many respects if carefully worked out. The writer would hesitate to advise such a scheme, except under exceptional circumstances. It is that the domestic supply should be entrusted to a company selling water by meter, and the general supply (including supplies to closets) should be in the hands of the municipal authority, and paid for by a general rate levied on all property. In addition, the municipal authorities would receive payment for any water they might dispose of for manufacturing purposes. It will be seen that, under this arrangement, the municipal authority would have under its control water-works (supplying fairly good water it must always be presumed) for supplying closets, road and public garden watering, sewer flushing, fire extinguishing, and to sell for manufacturing purposes. The company which supplied water by meter for domestic use, and for those manufacturing purposes for which pure water is indispensable, should also be under the supervision of the municipal authorities.

Such a system as the above would probably only be found worthy of consideration in the case of a town which possessed a supply of good water, but of so limited a quantity that the rapid growth of the city rendered an increased supply indispensable, and where there was an inferior supply near, which could be made available at small cost. By these means the consumption of the pure water would probably be reduced to such an extent as to be available for a much larger population, and at the same time, from the fact of the municipal authorities controlling

the house drains, closets, and flushing supplies, an improved sanitary condition might result. It is, however, not easy to imagine a town in such a position.

Rain water, as it falls, is in a comparatively pure state, and if proper measures are taken to preserve the surplus falling in wet seasons, and to keep it from contamination, it will generally be found that the rain falling in each watershed is amply sufficient to supply the whole of the inhabitants dwelling in their districts. If any scarcity exists, it is owing, generally speaking, to the want of proper care, or to the fact that the district is so subdivided under different authorities, that joint action for the proper conservation of the rainfall is impossible.

MODE OF DISTRIBUTION, WITH SOME REMARKS ON DUAL SUPPLY.

By HENRY J. MARTEN, M.Inst.C.E.

UNTIL comparatively recent times no attempts were made to afford what we now term "a domestic supply," that is to say, a supply of water distributed to and available within each house for general domestic purposes.

The large supplies of fine water introduced into the principal cities of ancient times, by means of the magnificent aqueducts of which there are many remains to this day, were directed, so far as distribution is concerned, to the supply of public baths and fountains, and possibly here and there to the supply, for similar purposes, of a few of the private residences of the wealthy classes.

A house-to-house supply, such as we have in modern times, was unknown and undreamt of. The supply for domestic purposes had to be obtained by the occupants of the houses either from the public fountains, or from the streams flowing from them, or was supplied in detail by

water carriers, somewhat after the fashion in which milk is now supplied from house to house. Although, according to Pliny, the ancients were aware that water under pressure rises to the height of its source, little practical advantage was taken of the knowledge of this fact. Water under pressure was occasionally conveyed for some distance through stone or earthenware tubes or in leaden pipes. The two former were, however, difficult to be kept tight, and the latter were not only very expensive, but, at an early period of their history, were found to act deleteriously on the water flowing through them. Although, therefore, immense volumes of water were frequently brought into ancient cities, as into Rome, where, according to Strabo, "whole rivers flowed through the streets," and where the total quantity so delivered probably exceeded three hundred gallons per diem to each inhabitant, there was practically no distributed domestic supply.

The inhabitants of modern London, therefore, although only furnished with a supply per head equal to one-tenth of that which used to flow into old Rome, are nevertheless infinitely better off than the ancient Roman, because the thirty gallons supplied to the modern Londoner are delivered exactly where he requires it, "upstairs, downstairs, or in my lady's chamber," and the supply is at all times available by the mere turning of a tap. We have here a good illustration showing how various combinations of applied science, united to the practical skill of modern times, have resulted in a tenfold economy, coupled, at a moderate estimate, with a tenfold advantage to the water consumer.

If modern London were supplied in the same wasteful and unscientific manner as ancient Rome, the quantity of water required for the purpose would exceed in volume the average flow of the River Thames at Kingston, and whilst this immense volume of water would be rushing from public fountains, and down open channels made for the purpose in the streets, the inhabitants would be totally *without* the comfort and advantage which they at present

enjoy of a domestic supply delivered under pressure into each of their houses.

Coming to modern times, the distribution of a domestic supply dates back from the time of Peter Morice, who, in 1582, erected waterworks for the supply of the City of London by means of pumps actuated by water-wheels placed in the first two arches of old London Bridge. He appears to have distributed the water under pressure through leaden pipes, but it is probable that a few years later these were replaced by wooden pipes, which, as early as the year 1628, were being laid down by the New River Water Company. These wooden pipes consisted of the trunks of elm trees, cut into lengths and bored longitudinally to an internal diameter of from 6 to 12 inches, in accordance with the internal pressure they were required to withstand. In the parts of the town lying at the lower level (where the pressure would be greatest), the diameter of the bore would be 6 inches, so as to leave a considerable thickness of wood between the inside of the bore and the outside of the tree. In the higher parts of the town, and near the reservoirs, where the pressure would be less, the bore would be gradually increased to 12 inches in diameter, a less thickness of timber being required in those parts. The joints of these wooden pipes were made by forming one end of the tree into a conical shape, and hollowing out the other to correspond; the several lengths, when laid, being then driven one into the other.

These wooden pipes, however, proved very defective, as the loss by leakage was estimated at not less than one-fourth of the whole quantity flowing through them. From decay and other causes they required also to be renewed on the average about once in every twenty years; and consequently, as at one time the New River Company had 400 miles of these pipes laid down, they had to take up and renew upwards of 20 miles in length each year.

Owing also to the small diameter of these wooden pipes, where they had to bear any amount of pressure, more than one line—and in one case no less than nine lines—of pipes

had to be laid side by side in the same street, in order to furnish the requisite supply.

When we reflect on the fact that at this period London was almost entirely without under drains, we may be able to form some slight idea of the terrible amount of moisture with which the foundations and basements of the houses adjoining these lines of leaky pipes must at all times have been saturated, and the disturbance which the constant repair and renewal of these pipes must have occasioned to the roads.

Bad, therefore, as matters are at the present time in London and other large towns, from the disturbance of the streets for such repairs, we of the present generation may congratulate ourselves upon the fact that, notwithstanding we now have gas-pipes, sewers, and under-ground electric wires in addition to water-pipes laid under the streets, the annoyance which we suffer from street disturbance is as nothing compared with that which our ancestors must have had to put up with in this respect.

There are no records to which the writer has access showing whether, in these early times, the supply for domestic purposes was on the constant or the intermittent system, nor whether the water was delivered at the ground floor of each house only or at a higher elevation. With wooden distribution pipes, such as these described, it would be very difficult to have a proper service of stop or shut-off valves, even if an efficient stop-valve for working under pressure were then invented. The frequent stoppages for repairs would necessarily assimilate the arrangements for supply to those of the intermittent system, which involves the necessity of having tanks, butts, or other capacious receptacles for the storage of water in each house.

In the early part of the present century, cast-iron mains began to be substituted for wooden water-pipes, and by the year 1820 the whole of the wooden pipes belonging to the New River Company had been removed and replaced by cast-iron ones. The substitution of cast-iron for wood introduced a new era into the art of water distribution, as

much higher pressures were rendered available, and leakage was materially reduced. The early cast-iron pipes, although made of the finest cold blast metal, were very rough productions. They were all cast horizontally, and in numerous cases, owing to the imperfection of the machinery, they were far from being either cylindrical or concentric, and thus were frequently thicker on one side than the other. They often, therefore, gave way when exposed to the working pressures they were called upon to sustain, the methods of testing them previous to their being laid being primitive and inefficient.

The first cast-iron distribution pipes were made with flanges on the same principle as the ordinary cast-iron pump-trees. These flanges were fastened together with bolts and nuts, the joint being made between the flanges, with an iron ring covered with tarred yarn or flannel. This method, however, soon had to be abandoned, as owing to the expansion and contraction of the pipes consequent on the changes of temperature in the water passing through them, the flanges were frequently torn off, and hence stoppages for repairs were numerous.

This defect was overcome by the introduction of the spigot and socket-pipe. The early joints of these pipes were made by driving soft wood wedges into the sockets, which were made wide for the purpose. When the wedges had been driven into the sockets as far as was considered prudent, the ends projecting beyond the sockets were cut off, and a few small iron wedges were then driven into the wood for the purpose of giving a final tightening. These joints were found to be a great improvement on the previous system of flanges ; but as the wooden wedges became saturated with water, they expanded, and frequently burst their sockets. This led to the abandonment of the system of jointing pipes with wooden wedges, and to the adoption of the plan of filling the back part of the socket with yarn tightly rammed in, and then running the remainder of the socket full of molten lead, which on cooling was caulked up, and so made a tight and permanent

joint capable of withstanding the full pressure to which the pipe might be subject, and, at the same time, of allowing for expansion and contraction without leakage.

This method, for the first time, gave those responsible for the distribution of water under pressure the advantage of having at command continuous distributing tubes of any length, and practically water-tight under any ordinary pressures.

The lead joint, as above described, with variations only for reducing the weight of lead used, or for adding to its security against being blown out by back pressure, has remained a permanent institution, a bar of lead being occasionally substituted for the molten metal.

In some cases, the old-fashioned method of jointing the wooden pipes has been imitated in their cast-iron successors by turning a conical end to the spigot, and boring the socket, so that, when fitted together, the pipes practically joint themselves without any other stopping.

With the introduction of cast-iron pipes, and greater pressure, the system of intermittent supply became more completely developed and established.

Under the intermittent system, the supply of water was not constantly laid on, as is now almost universally the case. The arrangement was to turn on the water from the principal main into the subsidiary distribution pipe, in any particular street, for an hour or an hour and a half a day; during which time all the people in that street had to draw and store a sufficient supply for the remainder of the twenty-four hours.

This system, with which the public were long content, ultimately fell into disfavour. Its inconveniences were great; the water was, as stated, only turned on for a very short time; the system necessitated the employment of a large number of turncocks, whose sole business it was to go round the districts to turn the water on and off. The intermittent system was also injurious on sanitary grounds, as it frequently happened that the vessels in which the water was stored were exceedingly foul, in consequence of

putrefying sediment left in them from previous supplies, and the stored water itself was apt to become impregnated with poisonous gases rising through the waste or overflow pipes of the cisterns which were connected with the sewers.

The sanitary defects thus inherent in the intermittent system were the fruitful source of disease and death, and early engaged the attention of the Board of Health presided over by the late Earl of Carlisle, and of which Mr. Edwin Chadwick, C.B., was the earnest and indefatigable secretary. After much inquiry the Board came to the conclusion that these evils could be remedied by the adoption of the constant supply system, which had been introduced at Nottingham by Mr. Thomas Hawksley, past president of the Institution of Civil Engineers, and was in successful operation there on a large scale.

Under the "constant" system, the supply is kept on the whole twenty-four hours, so that anyone, at any time of the day or night, by simply turning a tap in the house, can obtain a supply direct from the main without the intervention of any intermediate storage vessel.

When the proposition for affording a supply on the constant system was first broached by the Board of Health, it was met by a storm of opposition, some engineering advocates of the old system going so far as to allege that it would be a sheer impossibility to carry out the constant system, on account of the uncontrollable waste that would result from having the water always "on," and because, as there was no guarantee that everybody would not be drawing water at the same time, the main pipes would in consequence have to be of enormous magnitude compared with those necessary under the intermittent system, under which system it was alleged the supply could be more judiciously and economically manipulated.

The controversy on this question raged with great vigour from 1845 to 1850. About that time Sir Robert Rawlinson, C.B., having occasion to visit Wolverhampton in connection with a local inquiry under the Board of Health, asked the writer, who had then recently converted the

supply of that town from the intermittent to the constant system, and who at the moment had the means of doing so with great accuracy, to institute some experiments with a view to ascertain what, under the constant system, was the actual rate of consumption at each hour of the day. As the result of these experiments, the writer found that, so far from all the people drawing from the mains at the same time, the highest rate of consumption was only about two-and-a-half times the total daily supply; that is to say, that the main and distribution pipes under the constant system should be of a capacity sufficient to supply two-and-a-half times the ordinary daily consumption. Now, as under the intermittent system it was the practice to make the mains and distribution pipes of sufficient capacity to supply four times the ordinary daily consumption, these experiments proved that, so far from larger mains being required under the constant system, they might actually be made of smaller capacity than those required for the intermittent system. It was also shown that, with proper fittings in the houses, the consumption of water under the constant supply system was actually less than that under the intermittent system.

These facts being reported by the Board of Health, and afterwards given in evidence by the writer before a Committee presided over by the late Sir James Graham, and confirmed also by similar results in other cases, brought the controversy to a close in favour of the constant supply system, which is now almost universally adopted, and under which 263,904 out of the 671,888 houses in the London district are now supplied, as stated in the able and interesting report for May, 1884, of Colonel Sir Francis Bolton, Official Water Examiner under the Metropolis Water Act, 1871.

The introduction of the system of constant supply brought about other advantageous changes in the method of distribution. Under the intermittent system the water lay stagnant in the distribution pipes for at least twenty-two out of the twenty-four hours each day, and before

the introduction of filter beds these pipes were practically small settling reservoirs in which the sediment accumulated, and which sediment, when the water was turned on, was driven with the first rush, in a semi-putrescent state, into the household storage receptacles.

Under the intermittent system, but little attention was paid to fittings in the houses, as neither those supplying the water nor those receiving it troubled themselves much about waste, which in each case did not last more than an hour or an hour and a half each day. Hence taps, ball-cocks, house supply pipes and other internal fittings were old-fashioned and defective almost beyond description.

With the advent of the constant system, new descriptions of fittings were introduced to prevent waste, and to meet the requirements of the greater pressures at which the water then began to be delivered.

It may be safely affirmed that the constant system has brought about an extraordinary change for the better in all domestic water fittings; those now in general use displaying an amount of skill, ingenuity, and good workmanship far superior to anything ever before known.

Under the intermittent system the distribution pipe necessarily had a "dead end" in each street, because, the water requiring to be daily turned on or shut off, the pipe could only be connected at *one* end with the feeding main, leaving the other end isolated or "dead." The water near these dead ends became very foul from stagnation, and consequently the dead end required to be frequently washed out. This was effected by drawing a wooden plug fixed in a branch at the end of the distributing main. When this plug was drawn, it was not at all uncommon to see the water spouting out from it tinted with all the colours of the rainbow, from dark purple to the lighter tints, and emitting a most offensive odour, for when the water was shut off, it frequently happened that the distributing pipe was drained by a discharge at some low-lying part of it, and it then became filled with an atmosphere drawn through ground full of gas reek.

Under the constant system these evils, including those resulting from dead ends, are done away with; the distributing pipes being now constantly under pressure, no gas reek or other impurities can enter them, and being connected at each end of the street with the adjoining mains, there is a constant circulation throughout the whole system, whereby stagnation is prevented, as the water is always on the move towards the point of greatest consumption.

Very great improvements have also been made under the constant system, in the construction of the sluice valves for shutting off the water for repairs at any particular point. Under the intermittent system, the sluice valves were only made to shut against the pressure from *one* side, whilst they are now universally made to shut against the pressure coming from either side or in any direction. These valves, which are called "double faced," are the invention of Mr. James Nasmyth, so well known in connection with the steam hammer. The writer, then an articled pupil to the late Mr. Wicksteed, engineer to the East London Waterworks, had the privilege of assisting Mr. Nasmyth in preparing the first rough drawing of these "double-faced" sluice valves; and he well remembers the instantaneous rapidity with which that great mechanician not only grasped the point to be attained, but within an hour had so completely solved the difficulty to be overcome, that whilst alterations have been made in minor details, no practical improvement has been effected in that first design of his.

The method of connecting the house services with the main pipes has also undergone a great improvement. In early times the connection was made by driving a brass ferrule into a hole chipped or drilled through the main pipe. These ferrules were apt to be dislodged, and frequently blew out, and the fixing of them obliged the water to be shut off from the whole street during this occasionally tedious operation. These connections are now made by screw threaded ferrules, tapped securely into

the pipe by an instrument which obviates the necessity for any stoppage of the supply to other houses whilst the operation is being performed.

The arrangements also for the supply of water for fire extinction have been very greatly improved since the introduction of the constant supply system. In former times, in the event of a fire, the first thing was to find the turncock to turn the water into the main. This done, the old wooden plug had to be knocked out, often a work of time and difficulty; and then until all the empty tubs and tanks were filled up in the street there was practically very little pressure at the plug, and the supply was consequently scanty for some time. Thus most precious moments were lost. Now, on the contrary, the fireman goes to the nearest hydrant, inserts his standpipe, turns on the water from the constantly charged main pipe, and in a much less time than it previously took to call the turncock, he has a stream of water pouring into or over the burning building at the rate of 200 or 300 gallons a minute, and under a pressure sufficient to knock a strong man down at a distace of fifty yards from the nozzle of the fire-hose, and that without the intervention of any fire-engine.

Another little machine which has proved itself to be of great value in connection with constant supply, is the "Waste Water Detector," invented by Mr. Deacon, the engineer to the Liverpool Corporation Waterworks. This machine indicates and registers the flow of water passing through any particular pipe at any moment of time, and by its agency all undue waste and leakage are easily detected and traced. Thus the modern appliances in connection with distribution, if properly used and directed, are now nearly all that can be desired.

Except in very special cases, the writer is not an advocate for the "Dual System," that is a system under which two classes of water are introduced into a town; the one for dietetic purposes, and the other for washing, street-watering, sewer-flushing, fire-extinguishing purposes, &c. The dual system necessarily involves the laying of a

duplicate set of mains, and the fixing of a duplicate set of house fittings, with all the attendant annoyance and expense.

There may be cases where the circumstances are so peculiar as to make the dual system a necessity, and then the difficulty must be faced; but generally it will be found cheaper and better to manipulate the supply so as to make sure that none but water of a high class shall ever enter the mains, and so as to effect the whole work of distribution by one set of pipes and fittings.

WATER SUPPLY FOR FIRE EXTINCTION.

By J. H. GREATHEAD, M.Inst.C.E.

WHEN it is considered how vast is the havoc wrought by fire every year, and that we depend upon a supply of water, in all cases, to prevent much greater ravages, the importance of this subject will be at once recognised.

In London alone, it has been calculated on reliable data that the destruction of property in 1882 amounted to at least 2¼ millions sterling, and last year it was probably more; and it has been stated by a very good authority, Mr. Edward Atkinson, of the Boston Manufacturers' Mutual Insurance Company, that the losses by fire in the United States and Canada in the five years ending January 1st, 1879, amounted to 82¼ millions sterling, while the cost of insurance companies and fire departments in the same period amounted to 55 millions more, or together to an average of 27 millions sterling per annum.

It is difficult for the mind to grasp such figures; the last, however, is about equal to the whole rateable annual value of the metropolis.

If such losses as these were inevitable, it would be of *little* profit to refer to them, but it is because I believe

them to be to a large extent preventible, that I have ventured to bring the subject of water supply for fire extinction before you.

In the remarks which I am about to make, I purpose to refer largely to the case of this metropolis as being likely to add additional interest to the general subject, and because the reasoning which applies to this will apply in a greater or less degree to all other similar cases.

It may be useful at once to define what are the requirements necessary to be fulfilled in a water supply for fire extinction purposes.

In order to reduce, as far as possible, the destruction of life and property by fire, the fire extinguishing service should have water—

(1.) In copious supply.

(2.) In close proximity to the property.

(3.) Easily accessible.

(4.) Having sufficient and reliable pressure.

In nearly all cities the water supply has been introduced and distributed without reference to the fulfilment of these conditions. The quantity of water required for the extinction of fires is so infinitesimal as compared with the quantity required for all other purposes, that, except where the conditions have been naturally favourable, the water service is devoid of some at least of the qualities necessary to fit it for fire purposes. The result, in such cases, has been that mechanical contrivances have had to be provided to make good whatever deficiencies existed in the supplies, and dwellers in cities have become familiar with fire-plugs and fire-engines.

There are, however, some cities in this country where, the conditions having been favourable, the authorities having control of the water supplies have availed themselves wisely of Nature's gifts.

The most notable instances are those of Glasgow, Dublin, Liverpool, and Manchester. In all these cases the water supply is almost entirely by gravitation, and the result is that over the greater and most important parts of the

cities there is a good pressure and a copious supply of water, which has been made easily accessible by the introduction of numerous hydrants in close proximity. Here, then, we have, as nearly as may be, in four of the most important cities of the United Kingdom, a fulfilment of the necessary conditions of water supply for fire extinction.

An ordinary hydrant may be shortly described as a stop-cock on a water-pipe or main, to which hose may be attached for fire extinction, or other purposes. If for fire extinction, without the intervention of a fire-engine, the hose will, at its other end, be provided with a branch and nozzle. Upon opening the stop-cock, the water from the main, or pipe, will issue from the nozzle as a jet. The height of the jet will depend upon the pressure in the main, the quantity of water available, the length of hose employed, and the size and shape of the nozzle.

A fire-plug is a wooden plug driven tightly into a socket or opening in a water-pipe under the road. When water is required for fire extinction the plug is withdrawn, and the water issues from the opening, either into the street, where it is usually received by a portable tank, or into a stand-pipe inserted in place of a plug. It is obvious that plugs cannot be used where the supply is constant with a good pressure, and they have not been placed upon the constantly charged mains (the best existing supply for fire extinction) in the metropolis. Several forms of hydrants, and a fire-plug and stand-pipe, may be seen in the Water Companies' Pavilion in the Exhibition,

In order to obtain a good jet from a hydrant, it is necessary that the pressure of water at the hydrant, while flowing, should be about 65 lbs. per square inch. This will provide for overcoming the friction of the water in passing through an average length of hose, and will give a jet about 80 feet high from an inch nozzle. From the elaborate reports of the chief officer of the Dublin Fire Brigade, which he has kindly furnished to me, it appears that all the fires in Dublin, except those extinguished by *small hand* pumps, are put out by jets direct from the

hydrants, and that the prevailing pressure is about 60 lbs. per square inch.

So much has been written and said about hydrants, and the advantages to be derived from their use, during the last twenty years, that it is hardly necessary for me to discuss their merits as compared with fire-plugs. It is generally conceded that in all cases, whatever the water supply may be, whether constant or intermittent, high pressure or low, hydrants are superior to plugs as a means of letting the water out of the pipes. But it has been contended that so long as it is merely a question as between hydrants and plugs, the advantages of the former over the latter are not sufficiently great to justify any large expenditure upon them. When, however, the question becomes one as between hydrants and fire-engines, a wider view becomes necessary. Hydrants with a constant and copious supply, and good pressure of water, are recognised as being incomparably better agents for extinguishing fires than fire-engines, and the result of the introduction of hydrants into Manchester may be given in illustration. Mr. Bateman, the eminent engineer of the Manchester Waterworks, has stated publicly on more than one occasion, that the introduction of hydrants with a good pressure of water has resulted in a reduction of the losses from fire in Manchester to a small fraction (viz., one-seventh) of what they were before the introduction of the hydrants. And according to the report of Captain Tozer, the superintendent of the Manchester Fire Brigade, the amount of property destroyed has only averaged 4·3 per cent. of that at risk during the last ten years, while it will be seen presently that in places having no efficient hydrant services the losses are many times greater.

In Liverpool, the fire brigade is a branch of the police. The water supply is mainly by gravitation from reservoirs (from 400 to 600 feet above the low parts of the town), and there are numerous hydrants. There are 3 steam and 14 manual fire-engines. The population in 1881 was 548,650, and the area is $8\frac{1}{4}$ square miles. Of the 180

firemen, 170 do regular police duty. The average annual cost of the brigade for the three years 1880, 1881, and 1882, was £5325, or £9 14*s.* per 1000 of the population. The average annual number of fires in the same period was 219, but the loss by fire was not ascertained.

In Glasgow, there is a good supply of water by gravitation; there are about 5000 hydrants, and the majority of the fires are extinguished direct from the mains. There are 3 steam and 17 manual fire-engines. The 66 officers and firemen are supplemented by an auxiliary force of 52 policemen. The area of the city is 9½ square miles, and the population in 1881 was 510,816. The cost of the brigade to the ratepayers in 1882 was £5266, or £10 6*s.* per 1000 inhabitants; while the annual average loss from fire in the same period was £110,000, or about £215 per 1000 of the population.

In Manchester, the supply is also by gravitation from reservoirs at a considerable elevation (200 feet to 600 feet above the Exchange), and there is a constant high pressure supply. There are about 17,000 hydrants in the city and suburbs. Two steam and 5 manual fire-engines are retained, but are seldom used. The population in 1881 was 341,500. The area of the city is 6¾ square miles, but the fire brigade extend their operations beyond the city. There are sixteen stations, and the average annual cost to the ratepayers for the fire brigade during the three years 1880, 1881, and 1882, was £3547, or equal to £10 8*s.* per 1000 of the population. The average estimated annual value of property destroyed in those three years was about £80,000, or about £235 per 1000 of the population.

In Dublin, the supply of water is again by gravitation, and the pressure varies from about 40 lbs. to 80 lbs., being generally 60 lbs. when the water is flowing through the hydrants. There are numerous hydrants, and though there are 2 steam and 3 manual engines, they do not appear to have been used in the three years (1880–1882), within the city. The brigade consists of 32 officers and men. The population in 1881 was 249,602, and the area of the city is

6 square miles, but the operations of the brigade are not confined to that area. The average annual cost of the brigade for expenses and wages for the three years in question was £3286, or about £13 3*s.* per 1000 of the population. The estimated value of property destroyed averaged £31,144 per annum, or about £125 per 1000 of the population.

In Birmingham, the whole of the water supply is pumped, therein differing from the cases already referred to; but a system of fire hydrants has been recently introduced. The population (average of 1882 and 1883) is 411,690, and the area 13 square miles. The fire brigade consists of 27 officers and men, and there are 2 stations and 8 police stations, with apparatus. One steam and 5 manual fires-engines are retained, none of which were used for fire extinction in 1882, and engines were used twice only in 1883. The total water supply is 11½ million gallons daily, with a pressure of 40 lbs. to 60 lbs. per square inch. The average annual cost of the fire brigade to the ratepayers during 1882 and 1883 was £3250, or £7 18s. per 1000 of the population, while the average annual loss in the two years was £10,931, or £26 11*s.* 8*d.* per 1000 of the population, and this loss was equivalent to 3 per cent. only of the value of the property "at risk."

Having now described the operations, and their results in cities having efficient hydrant services, I propose to direct attention to some of the more important of the cities having no such services, and more particularly to New York and London.

In New York, the water supply is very copious, but it has not sufficient pressure for fire purposes without the intervention of fire engines. Hydrants have, to some extent, been introduced, and it is stated with benefit, as they permit more speedy access to, and prevent waste of, the water. The total supply is, according to the report of the fire department, about 100 million gallons daily; the population in 1880 was 1,206,300, and in 1881 probably 1,240,000. The area served by the fire brigade is about 39

square miles. In 1882, there were 50 engine company and 19 hook-and-ladder company stations, besides look-outs, fuel depôts, and store houses. There were 57 steam fire-engines but no manuals In the period 1880-82 the average force was 939 officers and men, and the average annual expenditure was £288,190, or £230 8*s.* per 1000 of the population. In the same period the average annual fire losses were £880,000, or about £710 per 1000 of the population. The quantity of water used by the fire-engines was about 40,000,000 gallons annually in the period 1880-2, or about 1-900th part of the total supply.

In London, the whole of the water supply is pumped, and the average pressure is quite inadequate for fire extinction without the intervention of fire-engines. A large number of observations were made all over the metropolitan area by the Board of Works, in 1876, and it was found that the average pressure was only about 30 lbs. per square inch, when there was no extraordinary draught on the pipes, such as that required for fire extinction. It is not surprising that this should be so. The pressure given by the water companies is that required by statute, or, otherwise, by the customers of the companies, and even if they desired to do so it is doubtful whether, in the words of the Select Committee of 1876-7, the companies would be "justified by their constitution in incurring expenditure for fire purposes," for which purposes alone it would be necessary for them to increase their pressure.

The quantity of water delivered for all purposes is sufficient to meet the demands for fire extinction. There are, according to Captain Shaw's reports, very few cases of short supply, and constant supply is being gradually extended voluntarily by the water companies. Hydrants have been put down by the Corporation throughout the City, and connected directly by branches with the constantly charged mains of the New River Company, and they have on several occasions been found useful, though the pressure is not such as to admit of fire-engines being dispensed with in all cases. A few hydrants have also

been recently introduced by the Metropolitan Board of Works to other parts of the metropolis.

In the matter of pressure, however, as already stated, the general metropolitan water supply is undeniably deficient. There is a copious supply of water, contiguous to the property to be protected, but it cannot be brought to bear upon a fire without the intervention of fire-engines.

The population of the metropolis, in 1881, was 3,814,571, and the Metropolitan Board of Works area is about 121 square miles, including the City's one square mile. There are 55 land fire-stations, 12 street, 127 fire-escape, and 4 floating stations; and the brigade consists of 588 officers and men. The annual average cost of the fire brigade for the three years 1880–2, was £99,880, or £56 4*s*. per 1000 of the population. It is somewhat difficult to arrive at the value of the property destroyed by fire in the metropolis, but a calculation based upon the contributions of the insurance companies to the support of the fire brigade, and upon evidence given by Captain Shaw and others before the Select Committee on the Fire Brigade, in 1877, would make it appear that in 1882 the value of insured and uninsured property destroyed by fire was probably considerably in excess of 2¼ millions sterling, or about £588 per 1000 of the population. As compared with the efficiently hydranted places already referred to, it will be seen that the cost of the fire-extinguishing service, and the fire losses are very high in London. This will be made very apparent upon an inspection of the appended Table A (page 562), which gives, in addition to the cost of the fire services and fire losses in the several places referred to, a statement of what the cost and losses would be in the metropolis, were the rates of cost and loss the same as in the other places.

It will be asked why the metropolis should have been allowed to remain year after year subject to the preventible drain of wealth indicated by these figures. The reply is that, the past and existing state of things have not been submitted to in ignorance or willingly, but the difficulties

surrounding the subject in the metropolis have been practically insurmountable.

More than twenty years ago, the Select Committee on Fires in the Metropolis directed attention to the extraordinary facilities for extinguishing fires then existing in Liverpool, Manchester, and Glasgow, and to the efficiency and small cost of the fire services in those places; and more recently, in 1876–7, the Select Committee on the Metropolitan Fire Brigade, having heard evidence as to the advantages of the hydrant systems referred to, recommended that hydrants should be put down in the metropolis at once wherever a constant supply was given, and that the water supply should be improved so as to give everywhere constant service and increased pressure. But it was found that to comply with these recommendations a permanent expenditure of £337,000 per annum beyond the cost of the fire brigade would be involved. Of this annual sum about £150,000 represented the increased cost of pumping alone; and since the quantity of water required for fire purposes is infinitesimal as compared with the quantity supplied for all other purposes, it is obvious that this expenditure of power, if the whole had to be pumped to the requisite height, would be out of proportion to the result obtained. I have made a calculation, based upon the relative quantities, and upon the evidence given before the Committee, from which it appears that for the purpose of discharging water through a hydrant upon a fire in this way, about 170 horse-power would be required for every gallon of water thrown. And there would be the attendant disadvantages that all the house fittings would have to be altered and strengthened, and the mains and pipes would have to be taken up, and relaid of greater size and strength, and at enormous inconvenience to the householders and the traffic in the streets; and the pressure would, in the greater part of the metropolitan area, be inconveniently great. This proposal also involved the great disadvantage that it could not be carried out until the water companies should have been ranged under one control.

As long ago as 1862, the late Mr. James Easton, who held the view that no satisfactory supply of water for fire extinction with constant high pressure could be secured in connection with the ordinary domestic supply, proposed to lay down a completely new set of mains to be used exclusively for fire purposes, but the cost would have been enormous. His estimate was £72,000 per square mile, and his proposal only extended to forty square miles of the metropolis. This area alone would have involved an annual cost for interest and working expenses of £150,000. A somewhat similar proposal was put forward by the Metropolitan Board of Works, on the advice of Sir J. Bazalgette, Sir F. Bramwell, and Mr. Edward Easton, in 1877, but with the addition that the water was to be taken from the chalk formation at about fifteen or twenty miles from the centre of London, instead of from the water companies' mains as was proposed by Mr. Easton, and that the supply was to be used for potable and culinary purposes after being pumped to the greatest attainable elevation in order that it might have sufficient pressure for fire extinction purposes. It was estimated that the introduction of such a system of hydrants would have resulted in an annual saving of £60,000 in the existing expenses of the fire brigade. This scheme, involving a dual supply to every house, was taken to Parliament, but was withdrawn; and in their annual report of 1878, the Board said that they "came to the conclusion, in view of the disfavour with which the scheme appeared to be regarded by most of the local authorities of the metropolis and others, not to bring it before Parliament again in the following session." Looked at purely from a fire extinction point of view there is one great objection to all the proposals that have been hitherto made, viz., that owing to the great variations of level in the metropolis, there would, in many localities, be insufficient pressure, while in others the pressure would be excessive.

In any water supply for fire purposes, it is certainly desirable that the pressure, in addition to being sufficient, should also be moderately uniform in the hose, whatever

may be the elevation of the locality. This uniformity is practically obtained at present by the use of fire-engines, but with the great drawback that the power requisite for giving the pressure is not available on the instant that the occasion for its use is discovered. The diagram B (on the wall) illustrates among other things the result of the vigorous efforts made by the fire brigade to reduce this evil to a minimum. It shows that since the year 1870, when Captain Shaw first began to publish the distances travelled by his engines—the distances run have increased from 11 miles per fire in 1870 to 34¼ miles in 1882. The number of journeys made has increased from 8000 to 29,000, and the total distance run from 22,000 miles to 66,000 miles in the year.

According to the evidence given before Sir H. Selwin Ibbetson's Committee in 1877, the fire-engines were then used for pumping at about one-fifth of the fires only. If that was still the case in 1882, then it follows that for each time the engines were used for pumping upon a fire they must have run on an average 172 miles.

When it is considered under what unfavourable conditions, and how uselessly the journeys are often made, some idea may be formed of the superiority of a system of hydrants where the power as well as the water is always on the spot ready for instant application. The same diagram illustrates also another feature of the fire brigade service, viz., the growth of its cost from the commencement of the old fire-engine establishment in 1833. It will be seen that the growth has been, and is very rapid as compared with the growth of the population. In the first year of the Metropolitan Board of Works' administration of this service, the cost of the brigade was under £41,000; in 1882 it was £106,552, or an increase in the period of sixteen years of 160 per cent., while the population increased only 28 per cent., and the number of fires 44 per cent. In the year 1883, the cost had further increased to over £115,000. It must not be supposed for a moment that this increase is to be regarded as unnecessary under existing conditions.

The cost of the London Fire Brigade is, thanks to Captain Shaw's admirable organisation, still small as compared with some other unhydranted cities. In New York, as already stated, the cost is very much greater for less than a third the population and area. There the average annual cost for the three years, 1880–3, was over £288,000, and it appears to be growing almost as rapidly as that of London, though on the other hand the population there is growing more rapidly. Paris, also another practically unhydranted city with half the population, spends proportionately more than London for fire extinction.

In Paris, the water supply is partly pumped, and partly acts by gravitation. Street hydrants have, to some extent, been introduced. In certain cases, where the pressure is sufficient, they are used without the intervention of fire-engines, but the water supply is not such as to admit of this being done generally. It is intended, however, to increase the number of hydrants to 8000, and ultimately to make them universal, and to dispense with fire-engines. The total daily supply of water is about 82 million gallons. The population is 2,269,000, and the area 29 square miles. The fire-brigade, numbering 1743 officers and men, is an armed force lent for this special service by the Minister of War, and is not called out for purposes of war. There are 11 barracks, 10 steam fire-stations, and 80 small stations in addition to 40 look-outs; there are also 12 steam and 80 manual fire-engines. The average annual cost of the fire extinguishing service is £86,600 for the two years, 1883 and 1884, or about £38 3*s.* per 1000 of the population, but this cost does not include the rent and repairs of the barracks, quarters, &c., which belong to the Prefecture of the Seine. The estimated annual average losses for the three years, 1880, 1881, and 1882, were £431,300, or about £122 10*s.* per 1000 of the population.

The question of the cost of fire extinction, again, is no the sole consideration; behind that there is the question of fire loss, or the destruction of property by fire, and the loss of life. Putting aside the last and highest question as

being one not altogether dependent upon the extinguishing service, I propose now to direct attention to the question of fire losses as affected by the absence or presence of efficient hydrant services.

In describing the hydranted cities, I have already given the fire losses in four of them, viz., Glasgow, Manchester, Dublin and Birmingham, in accordance with the published estimates, and I have shown that the losses are—in Glasgow £215, in Manchester £234, in Dublin £125, and in Birmingham £26 11*s.* per 1000 of the population. In the case of New York, the losses are published in detail, and amount to about £710 per 1000 of the population, as compared with £588, the loss in the metropolis, as estimated by myself.

The Table A (on p. 562), has been prepared in accordance with the facts I have stated; but in order to give the figures a practical bearing in the case of the metropolis, I have added two columns which give the costs and losses of a place having the population of London, at the same rates as each of the places considered. It will be seen that the annual cost of extinction by hydrants, if it were at the same rate as Liverpool, Glasgow, Manchester, and Birmingham, would be from £30,000 to £40,000; and at the same rate as Dublin, £50,000; while if it were at the same rate as New York, the cost would be £886,000, instead of £99,880, the average annual cost in London in the years 1880–2.

The diagram H (shown on the wall) has been prepared from Captain Shaw's table already referred to, and it seems to place the value of efficient hydranting in a very striking light. From the table referred to have been compiled the figures, giving the cost of the fire brigades in a number of important towns at the date of the compilation of the table (1877). The cost in the hydranted cities, viz., Glasgow, Liverpool, Manchester, and Dublin, has been shown in red. The blue line shows the cost in a number of American cities. Paris and London, having populations respectively twice and over threefold as great

as New York, are not shown, but from the table and the remarks upon it, it will be gathered that in both those cases the cost would be far above the rates shown by the red colour, which has been extended to embrace a place of the size of New York.

In the foregoing remarks, I have simply taken population as the basis of comparison between the several places. I do not pretend to say that there are not exceptional considerations apart from the question of water supply, such as areas, character and proximity of buildings, habits of people, and so on, which would, and no doubt do, materially influence results, but the distinction between the hydranted and unhydranted places is so broad and marked where the places are of such different characters on the one hand as Glasgow, Liverpool, Manchester, and Dublin, and on the other hand as London, New York, Paris, and Birmingham, that it must appear to all that the absence or presence of efficient hydranting far outweighs any other consideration.

It now remains for me simply to add that, having for some years devoted much study to the subject, I believe that, notwithstanding all the difficulties, only the chief of which have been adverted to here, there are methods—or perhaps I ought rather to say there is a method—by which such cities as London, New York, and Paris may be efficiently hydranted at a comparatively small cost, and practically with very trifling inconvenience, which method I have already described in papers read at the last meeting of the British Association, and before the Institution of Mechanical Engineers.

It is, however, obviously impossible, within the limits of a single paper, to discuss the whole question. I therefore content myself on this occasion by advancing the proposition that efficient hydrants form, as far as our experience goes, the only effective weapon with which fire brigades can successfully cope with fires.

APPENDIX.

TABLE A.—ANNUAL COST OF FIRE EXTINCTION, AND ANNUAL AMOUNT OF FIRE LOSSES, IN SOME HYDRANTED AND UNHYDRANTED CITIES.

Average of 3 years, 1880, 1881, 1882.

	Population, 1881	Area Square Miles.	Cost of Fire Brigade.	Cost of Fire Brigade per 1000 Inhabitants.	Cost of Fire Brigade of Metropolis at same rate.	Loss.—Property destroyed by Fire.	Loss.—Property destroyed by Fire per 1000 Inhabitants.	Loss of Property in Metropolis at same rate.
* HYDRANTED.		£	£	£ s.	£	£	£ s.	£
Liverpool	548,649	8·28	5,325	9 14	37,000	—	—	—
Glasgow	510,816	9·55	5,266	10 6	39,290	110,000	215 7	821,542
Manchester	341,508	6·7	3,547	10 8	39,670	80,180	234 16	895,644
†Dublin	249,602	6·0	3,286	13 3	50,200	31,144	124 16	476,050
Birmingham, 1882-3	411,689	13·15	3,250	7 18	30,115	10,931	26 11	101,287
* UNHYDRANTED.								
London	3,814,571	121	99,880	26 4	99,880	2,242,400	587 19	2,242,400
New York	1,240,000	39	288,190	232 8	880,490	880,000	709 14	2,707,150
‡Paris, 1883-4	1,269,023	39	§86,600	§ 38 3	145,500	‖431,300	‖192 10	734,300

* The term "hydranted" and "unhydranted" indicate the presence or absence in each place of a complete system of hydrants which are used for fire extinction without the intervention of fire engines.

† The cost of the Fire Brigade has been reduced from £3616 in 1880, to £3053 in 1882.

‡ A large number of fire hydrants have been put down, and some have been used without the intervention of fire engines, but the average pressure is not such as to admit of this being generally done.

§ Average of 1883 and 1884, exclusive of rent and repair of quarters, barracks, &c.

‖ Average of 1880, 1881, and 1882.

REMARKS ON THE DISTRIBUTION OF WATER.

By JOSEPH QUICK, Jun., M.Inst.C.E.

Next to the importance of securing a supply of water of good quality for the requirements of a city or town, is that of its distribution, for however superabundant the source may appear to be, the advantages to be derived from its use, and the number of those whom it may benefit, must necessarily be in a great measure dependent upon the way in which it is distributed.

The author does not propose to enter here into the question as to the works necessary to bring an ample supply of water into a city or district, but assumes, for present purposes, that such works have been well executed, and that properly proportioned distributory pipes have been laid, and service reservoirs or other means provided for affording a supply of water at high pressure throughout the district to be supplied.

The history of the water supply in England is eminently instructive, as showing not only the various phases through which it has passed as refinement and sanitation have advanced; but also as proving the absolute necessity of proper control being exercised with regard to its distribution.

Not to weary my hearers with unnecessary detail on this point, it may suffice to refer to the discussions which have taken place during past times, as to the relative merits and practicability of the systems known as "intermittent" and "constant" supply respectively.

It is within the author's recollection when it was the exception, instead of being, as it is to-day, the rule for towns in England to enjoy the advantages of constant supply; but up to this moment there are many instances,

notably in the metropolis itself, where the intermittent supply still, either wholly or partially, prevails. It is hardly necessary to explain that by "constant" as opposed to "intermittent" supply, the author refers to the difference between the mains and house-service pipes being always charged with water, so that it can be drawn off direct from the main at any hour of the day or night by the consumer, instead of, as on the intermittent system, the supply being only turned on for a limited time, varying from half-an-hour to two hours per day, during which time any receptacles, cisterns, &c., provided by the consumer, have to be filled, and suffice for use until the operation of refilling them is repeated on the next and subsequent days.

Of the advantages of the constant supply for domestic purposes, independent of its being immediately in case of fire, it is almost needless to speak, especially for the poorer class of houses in cities and towns, whose only receptacle frequently consists of a dilapidated and uncovered water-butt, the water in which is exposed to all the evils of contamination from the atmosphere and other sources. No one who has travelled by the railway in any part of London can have failed to observe, in the crowded districts traversed, innumerable instances of this kind, which are amongst the most prolific causes of disease amongst the lower classes of the population. It is, indeed, little short of a crime on the part of those responsible for this order of things, that human beings should be compelled to obtain their drinking water from such contaminated receptacles; and it is doubly wrong that, after the suppliers of water have done all in their power to improve, by filtration and other means, the quality of the water, and to prevent its pollution at its source, it should, after delivery to the consumers, be allowed to thus become deteriorated in quality, and a source of danger to health.

One of the great advantages offered by the constant supply system, as already stated, is to abolish the necessity for any of these miserable receptacles; and it is difficult to imagine a greater blessing, or one more conducive to sani-

tation, than the introduction in their place of water direct from the water mains to the consumer's tap.

Although the author has alluded thus prominently to the evils attendant upon the butts so frequently found in the dwellings of the poorer classes, it is not to be supposed that the evil is limited to them ; on the contrary, in some houses of the best class, where cisterns are employed, the same evils, although in a minor degree, prevail. The author feels justified in asserting, as the result of upwards of twenty years' day-to-day experience in connection with the water supply of London, that the periodical cleansing of cisterns, from which it is impossible to exclude a certain amount of dust and dirt, even in first-class houses, is the exception rather than the rule, and that, in a large percentage even of the better class of dwellings, a further serious evil arises in consequence of the overflow pipes from such cisterns communicating direct with the drains, without the intervention of a proper trap, thus allowing the foul gases from the drains to communicate with, and thereby contaminate, the water in the cistern.

The obvious question arises, under the above circumstances, why the constant supply is not universal throughout the length and breadth of the land ? This is a question which has puzzled many a Parliamentary Committee, and although it has made great progress, it is still but imperfectly understood. The difficulty has usually been ascribed to either the inability or unwillingness of the water authorities to adopt it, on the score of expense ; and this has frequently been brought forward as one of the reasons in favour of the transfer of the management of the water supply from private companies to a public body ; but, on closer investigation, and to the few professionally familiar with the subject, it is apparent that the real difficulty is not to be attributed to this cause, which would have been almost equally difficult to cope with had the water supply been under public instead of private control.

The real difficulty in effecting the change of system consists in having to graft it on to the old state of things,

which involves the re-arrangement of the various pipes, taps, closet apparatus, &c., in the houses in such a manner as to prepare them to receive the constant supply, and at the same time prevent waste of water.

It was a long time before the absolute necessity of stringent regulations to prevent waste was understood or appreciated, except by those immediately conversant with the practical everyday working of waterworks; but eventually it became evident, even to those most clamorous for the new system, that the enforcement of such regulations was absolutely necessary to ensure its successful working. When once this was officially recognised and admitted by Parliament to be indispensable, the necessary powers were granted, both to the metropolis and in the provinces, of which the latter afford some instances of a highly successful result, both in the changing of the system from intermittent to constant supply at the same time, and the effecting of a large reduction in the quantity of water required, after providing an ample supply for all purposes to the inhabitants.

The author may mention as an example, the town of Portsmouth and surrounding districts of Portsea and Southsea, where the Water Company supply a population of 140,000, occupying 27,545 houses, of which a large number are of a very small class. The company was established in 1857, and until the year 1876 the supply was intermittent throughout the borough; but in 1873 an Act of Parliament was obtained, under the advice of the author's firm, entitling them to make the necessary regulations to prevent waste, and these regulations were sanctioned by the arbitrator appointed, Dr. Pole, F.R.S., in April, 1876.

It will be seen by these regulations that while ample power is given to the company to require waste-preventing apparatus to be used, the company are restricted from requiring alterations of fittings until the existence of such waste is actually proved; the effect of this has been to necessitate more frequent inspection, and to some extent to cause delay in introducing the new system; nevertheless,

the activity of the company's resident engineer, Mr. H. Smith, was such that in March, 1880, or within four years from the official approval of the regulations, the constant supply was given to the whole borough, and has continued without interruption to the present time. Owing, however, to the very extensive supplies for trade and public purposes, and for the use of her Majesty's Dockyard given by the company, the actual supply for all purposes still amounts to 30 gallons per head per day; but there is every reason to believe that by the means the company are still taking to detect cases of waste, as hereafter described, the consumption will be still further considerably reduced.

Probably the extent to which waste of water exists is best tested by asking the question—"What is the quantity really required per head per diem," and comparing it with the quantity actually supplied to any particular town or district; the answer to the former will of course depend upon local circumstances; for instance, in a manufacturing town, or one where unusually large quantities of water are required, for Government establishments, breweries, or trades requiring considerable supplies, the consumption per head per day will be much greater than in a purely residential town or district. When new waterworks are being constructed for a district, it is usual to estimate for works calculated to supply thirty gallons per head per day; but this is not because in well-regulated works the consumption reaches to that quantity, but to provide for a maximum supply being at hand during the driest season of the year, when the consumption is at its greatest. This quantity, however, is in many cases exceeded, notoriously so at Glasgow and New York, while in London it amounts to upwards of twenty-eight gallons per head per day. But as examples of what it should be where proper regulations to prevent waste are adopted, it has been incontestably proved (by Mr. Ayris M. Inst. C.E.) that in the case of Norwich and Sheffield, that a supply in the former case of fifteen gallons, and in the latter of eighteen gallons per head per day suffices for all wants, domestic and otherwise.

It is evident, therefore, that by a proper system of supervision, and the enforcement of the use of proper waste-preventing apparatus, the supply may be kept, under ordinary circumstances, within the above limits, without any way stinting the supply.

Another notable case is that of the city of Amsterdam, where the author's firm constructed the works. The supply is constant, and there are no less than 1137 tread consumers supplied by meter, but the total consumption per head per day, for all purposes, even in the hottest seasons, does not exceed fourteen gallons. This company, unlike the London Water Companies, had the great advantage of prescribing proper fittings from its commencement, in 1856; and this circumstance, combined with the fact that the W.C.'s are not connected with any system of main drainage, accounts for the small quantity of water supplied, which, however, is ample for the wants of the inhabitants, notwithstanding the notorious fact that the consumption of water for washing purposes, in Dutch households, is abnormally large.

The most fertile sources of waste of water, and yet the most easily preventible, are those from the W.C., and the overflow pipe from cisterns, which frequently leads direct to the drain; the former is remedied by the employment of a service box placed between the supply pipe and the W.C.; and the valves for the ingress and egress are so arranged, that before the latter is opened, the former must be closed, so that no direct communication can take place between the main and W.C. itself. The waste from the overflow pipe is avoided by breaking the connection between the pipe and the drain, by converting the overflow into a warning pipe, fixed in such a position that whenever an overflow or waste of water takes place, it can be seen by an inspector from the outside of the premises; or it is so arranged as to flow into some inconvenient place; in either case it insures the cause of waste being speedily discovered and the cause removed.

The "detection" of waste is more difficult than its

prevention; for whereas the latter can, when once discovered, be checked or stopped by well known simple mechanical contrivance (*e.g.*, those above referred to and described in Clauses 11, 12, and 20 of the Portsmouth Water Company's regulations annexed hereto), it must be remembered that only a certain portion of the apparatus for conveying the water from the main to the house is exposed to the view of the inspector of fittings on behalf of the water authority; for instance, it frequently happens that, especially in certain soils, the service pipes are defective, and certain leaks may exist and remain undiscovered for years; the waste of water from this cause the author believes to be much greater than that usually attributed to it, and he believes much of it to be due to the employment of wrought-iron service pipes of inferior strength and quality. Many (hundreds of) instances could be quoted where such pipes have been found, after only a few years' use, to be decomposed from the outside, leaving the fibres of the iron stretched like violin strings, and barely holding together; imperfectly made joints or connections, or careless workmanship, or broken pipes from unequal subsidence, are also causes of underground leakages. To ascertain their extent and position forms an important feature in any thorough system of water inspection.

Until a few years since, the detection of underground or concealed waste of water by scientific or semi-self-acting means was comparatively unknown, but since the advantages of the constant service system have been more generally acknowledged, and the absolute necessity of preventing water waste admitted, much attention has been paid to the subject, and reliable mechanical means are now available for detecting, isolating, or concentrating at any particular point or district any waste that may be going on. The instrument known as "Deacon's Waste Water Meter," the invention of Mr. G. F. Deacon, M.Inst.C.E., is at once not only a waste detector and localiser, but also a self-acting silent registrar of the exact extent and amount of the waste at any particular spot. A detailed description of that

instrument was given in a paper read by Mr. Deacon at the Society of Arts, on May 17th, 1882; it is therefore unnecessary to repeat it here, further than briefly to describe it as a self-acting registrar of the velocity at which the water is passing through it any moment, the result being registered by a diagram on a sheet of paper, placed on a drum worked by clockwork. This instrument is so sensitive that, in the words of the inventor, "in a main supplying 3000 or 4000 persons, the opening of a single tap is shown by a sudden fall in the line, and the quantity per hour by the difference in the flow before and after the opening; if the closing of the tap is shown, the duration of the flow is obvious also."

The extent to which waste has been reduced in Liverpool and other large cities by the employment of this meter, is matter of notoriety in the waterworks world; the author begs to add his personal testimony to the advantages gained by its use at Portsmouth, as shown in the following table:—

BOROUGH OF PORTSMOUTH WATERWORKS COMPANY.

TABLE SHOWING RESULTS OF USE OF DEACON'S WASTE WATER METERS.

District.	Number of services.	Estimated Population.	Date of fixing Deacon's Meter.	Reduction per head in Daily Supply.	Total Reduction per day.
				Gallons.	Gallons.
Queen-street . .	217	1,085	October, 1882 .	3	3,255
Daniel-street . .	626	3,130	September, 1882 .	13	40,690
North-street . .	550	2,750	June, 1882 . .	3	8,250
Charlotte-street .	1,100	5,550	November, 1882 . .	12	66,600
King's-road . .	796	4,776	May, 1883. . .	12	57,312
Fratton-street .	857	4,285	July, 1883. . .	9	38,565
Greetham-street .	512	2,560	,, . . .	9	23,040
St. James'-street.	530	2,650	May, 1882 . .	24	63,600
Hanover-street .	360	1,800	April, 1882 . .	18	32,400
Havant-street .	227	1,135	June, 1882 . .	14	15,890
Broad-street . .	252	1,260	January, 1882. .	43	54,180
Barrack-street .	125	625	February, 1882 .	25	15,625
Warblington . .	420	2,100	,, .	28	58,800

Waterworks authorities have now, therefore, at their command both the means of detecting waste, and, having

detected it, of requiring proper waste-preventing apparatus to be used, *i.e.*, assuming that they possess the necessary statutory powers; in cases where such powers do not exist, their necessity is so obvious that there is but little difficulty in obtaining them from Parliament, under proper restrictions. In the case of the metropolis, the necessary regulations were determined by a Committee appointed by the Board of Trade, in 1871, and the operation of the clauses in the Metropolis Water Act, 1852, requiring the London water companies to furnish constant supply, which had lain dormant since that time, at once commenced, and considering the Herculean proportions of the districts included within the radius which those companies supply, great progress has been made. From 52,265 houses receiving the constant supply in 1873, the number have increased as follows:—

1874	59,281
1875	70,160
1876	75,016
1877	97,343
1878	122,242
1879	138,624
1880	160,674
1881	185,076
1882	203,443
1883	226,376

Hitherto the author has only dealt with the supply as affecting private consumers, whose use of the water is presumably limited to domestic purposes. We have now to consider the question also of the supply to manufacturers and those cases where water is consumed for other than domestic purposes.

The introduction of water meters, for the purpose of measuring the quantity of water actually supplied to any consumer, has materially simplified the mode both of supplying and charging for water employed for manufacturing, or purposes other than domestic. Formerly, it was exceedingly difficult to form an accurate idea of the quantity used, especially at public institutions or large

works, where frequent inspection was almost impracticable; re-surveying of premises, to ascertain whether additional supplies were being used, and the alteration of the annual charge for water, was a source of perpetual disagreement between the suppliers and the supplied. The water meter has, however, put an end to this, and proved equally advantageous to all parties interested. By its introduction an enormous amount of waste of water has also been detected, in many instances, to a large extent. One notorious case occurred in the metropolis. At a well-known popular restaurant, the water company having erected a meter, the quantity registered as passing it was so enormously in excess of the amount previously paid by the proprietor, that he naturally complained to the company. The meter was thereupon tested, but found to be accurate. Unconvinced, however, the proprietor threatened to have the supply cut off, and to resort to a very fine spring which he had in the basement of his premises. He commenced operations accordingly, only to find that the "very fine spring" consisted of a leakage from a broken pipe, which had been, doubtless, running for years, and which of course accounted at once for the abnormal consumption recorded by the meter.

As regards the most desirable water meter to be used, it is so large a question as to be worthy of a distinct paper. Speaking generally, however, those in practical use may be divided into three classes:

No. 1. The low-pressure meter.

No. 2. The inferential meter.

No. 3. The positive meter.

The disadvantage of the low-pressure meter, which is constructed much upon the same principle as the gas meter, the quantity being measured by the filling and emptying of compartments in a revolving drum, is that it must of necessity be fixed at (or rather above) the highest point where the supply of water is required, thus making it more expensive to fix, in consequence of the extra length of service pipe required, and more difficult of access for

inspection ; it also affords the opportunity to the consumer of fraud, by making connections to the pipe between the main and the meter ; and although this latter may not be considered in the great majority of cases an objection, it is at any rate not desirable that the opportunity should be given. On the other hand, there are many instances in which—especially where large quantities of water are supplied in bulk into a large reservoir from one community to another—this meter may be applied with peculiar and especial advantage.

The second, or inferential meter (usually known as Siemen's meter), is based upon the principle of the re-action turbine, or Barker's mill, and is set in motion by the passage of water through it, the velocity of rotation being checked by veins, or plates, projecting from the revolving drum.

The author has some thousands of these meters now at work under his charge, and taken as a whole, their accuracy is surprising ; it is quite true that, under very exceptional circumstances, *i.e.*, when the water is drawn off in minute quantities (or the capacity of the meter is much greater than its work), a certain quantity can be passed without registration ; but in practice this does not take place to any appreciable extent, except in the case of large-sized meters, as, if the draw-off outlet is reduced to such an extent as to affect the working of the meter, the quantity passing is so small as not to reach the minimum annual water rent which the consumer is usually bound to pay, even if the consumption has been below a certain amount. These meters have the advantage of being moderate in price, compact, and liable to a comparatively small amount of wear and tear.

3. The positive meter, of which there are many varieties —*e.g.*, Kennedy's, the Manchester, and Tylor's,—measures, as its name implies, the actual quantity of water displaced by one or more pistons, which are themselves worked by the pressure of the water. These meters are, however (with the exception of Tylor's) more expensive and more

bulky than the inferential meters; they are, in fact, machines and require the attention of machines; at the same time, under proper management, they are not liable to get out of order, nor more costly for repair. At one waterworks which the author designed, every house is supplied by a Kennedy's water meter, at a price per 1000 gallons; a minimum rent being paid to the Water Company, proportionate to the size of the premises supplied.

In the foregoing remarks the author has endeavoured, he fears somewhat imperfectly, to compress within the limits assigned to this paper a synopsis of the various primary points in connection with the distribution of water. Were he to have attempted to go into detail, the paper could have been materially extended, but he trusts that he has said enough to draw the attention not only of those connected with water and water supply, who are already aware of the difficulties of the subject, but of those who are the recipients of the water supply provided for them at so much outlay, foresight, and trouble, to the very great importance of preventing the waste and misuse of so valuable an element. It is a notorious fact that all the available watersheds are being gradually occupied, and that year after year witnesses large communities being compelled to go to long distances for additional supplies of water. Glasgow to Loch Katrine, Manchester to Thirlmere, Liverpool to Vyrnwy, and the metropolis itself bound in the near future to resort to other sources as auxiliary to, or even possibly in substitution of, a portion of its present supply, all afford instances of this necessity; and hence the question of economy in the consumption of water is one the importance of which cannot be overrated. By all means let every individual, rich or poor, use abundantly all that is neccessary for every legitimate purpose, but beyond this let them be equally careful that no waste should be allowed. This is not only a duty of the consumers to the suppliers of water, but to their fellow-men, and while all who neglect it will deserve the reprobation, the gratitude of the community will be eminently due to those who will

not allow one of the greatest blessings afforded to us to be diverted from its career of usefulness and benefit to humanity. To an audience like the present, largely composed of brother professionals, the author is aware that a great deal contained in this paper will not be new; but, on the other hand, there are, doubtless, those amongst the visitors to whom the subject is wholly or partially foreign, and he wishes this paper to be regarded not so much as a scientific as a practical paper, addressed to the community at large on an important domestic subject, in which every man has a direct interest.

DISCUSSION.

Mr. T. SUFFIELD wished to enforce the recommendation often made by Sir Francis Bolton, as to the arrangement of overflow pipes of cisterns. The ends of such pipes should discharge into the open air, or into a rain-water pipe unconnected with the drains. He thought it would be well for water companies to make an arrangement with plumbers, and offer small rewards to their workmen, for the discovery and prevention of waste of water. The fittings of cisterns were frequently defective, the ball-cocks being badly made and badly fitted. He objected to the removal of standing waste pipes; he thought that the upper ends of such pipes should be closed, and then, by lifting them out, the means was provided for cleaning out the cistern. The drains should be more frequently flushed, with a view to the removal of the causes of the stoppages. He laid great stress on the importance of a constant supply.

Mr. E. K. BURSTAL desired to say a few words with regard to the use of the waste-water meter. He would not cry down the use of that most useful apparatus which Mr. Deacon had invented, but he was quite certain that useful results could be obtained without that instrument. He had known himself, in two towns, that inspectors had to be sent

round because that instrument merely showed that there was a waste, and they then had to send inspectors round to see where the waste was. He maintained that the use of that expensive contrivance might be dispensed with, and they might, by sending inspectors round with sounding rods and the necessary appliances, find out where the waste was, and check it, without using that apparatus. He might be thought old-fashioned in saying so, but he believed that to be the case. With regard to the cisterns which were generally in use for the supply of closets, he was much disappointed when he looked upon the exhibits of the London Water Companies in the Exhibition, and found the assortment of curiosities they had brought together. They had brought forward vacuum systems, and every sort of automatic system imaginable, but there was not one single instance of the double valve system, which had been introduced by Mr. Aris, some of which were now in use in Yarmouth, Lowestoft, Norwich, Derby, Leicester, and Oxford, and in all the towns noted for having a model consumption of water. In the towns of which he was managing engineer, they did not allow this automatic apparatus to be used, because they found they were waste-producers, not waste-preventers. In fact, to show how imperfect they were, one of the syphon systems could be set to run continuously, and that was a system which one of the London Water Companies was recommending for use. He really thought that, instead of introducing these patents to the public—and the public were consequently getting rather puzzled to know what to use—they should adopt such a plain double valve system as was placed before them, so that they could not both open at the same time. The advantage of a cistern upon that principle was that they would have for, say, a fourth or a fifth flushing, eight or ten gallons in reserve, and assuming a constant supply, if the water happened to be turned off for half an-hour during the day, they would still have a reserve in the cistern, and that would render the use of large 100 gallons or so cisterns unnecessary. They would then only have to put their taps

on their rising service, and they would not want any cisterns at the tops of the houses at all. That could be done at very little cost in provincial towns, and it could be done in London. The remedy for the difficulty rested with the ratepayers, but the class of ratepayers who were the owners of small properties were the great obstructives. With regard to the water supply for fire extinction, the size of the service mains had not been taken into consideration for that purpose. It had been provided in all the local legislation that proper water mains should be laid down, and very few mains of less than 4 inches in diameter had been laid down since 1847; therefore, it was not right to say that provision had not been made for protection against fire; 1½ inch mains were sufficient for domestic purposes, but they wanted 4 or 6-inch mains for an efficient fire supply. Mains of that size had been laid in the town with which he had been connected from 1849 down to 1855. With regard to the dual system, they knew it was impossible to construct a service upon a principle of that kind. If one tap was placed beside the other, no one could ever tell which tap to go to, and the expense was a very strong reason against its adoption; and if what they had heard with regard to the quality of the water from the alarmists was true, which he, however, did not think was the case, it would not be a proper thing to put in the power of servants to give them contaminated water from the tap on the right hand sink when they were supposed to give them pure water from the tap on the left.

Mr. CHADWICK would say a few words with regard to the paper on fire prevention. In Liverpool, where a great deal of incendiarism prevailed, the chief magistrate came to ask his advice as to what they should do in the way of prevention, and he suggested that they ought to put the water on the constant system, hydrant the streets, and place the keys of the hydrants in the hands of the police, so that on the occurrence of a fire, there might be no loss of time, no running to distant stations, as the men would be able to apply it at once. That system had been adopted also in

Manchester, Glasgow, and in other places. A Committee of the House of Commons had also sat upon the subject, and it was shown that the effect of the adoption of that system was that they could bring the water to bear in about three minutes on the average; whereas, by sending for a distant fire brigade, however well organised, it was twenty or twenty-five minutes before they arrived at the fire. They afterwards improved their organization, and brought the time down to fifteen minutes, but Mr. Braithwaite, the late Chief of the Fire Brigade, stated, that for the efficient protection of life and property, you must have the assistance within five minutes, and this system brought it within three minutes. What had been the authenticated experience of its employment? Why, it had reduced the insurance risks in Manchester, Liverpool, and Glasgow, where this system was carried into effect, by fully two-thirds, or rather more, and the loss of life had been reduced in the same proportion. The Board of Works had raised objections to putting the keys of the hydrants in the hands of the police. There were 4,000 men always on duty, patrolling the streets at night, but they objected to their having them, and said they must keep the control to themselves. It appeared that in the mere greed of power, which had not hitherto been withstood, they would keep everything in a condition of insecurity to the public, by keeping the keys out of the hands of the police, who could act immediately upon receiving information of a fire, and that in the face of the experience as to the saving of two-thirds of the losses by fire! There were double as many police-stations as there could be fire brigade stations, and he could not imagine how anybody could insist upon their separation for this purpose, at the expense of an enormously great destruction of life and property by fire. That system should also be applied in the theatres; the police had to be there for ensuring order, and they ought to have charge of all waterworks and appliances for the immediate extinction of fire. The most scandalous thing he knew was the ignorance of members of Parliament, who could go on acquiescing with the maintenance

of the present system in the face of such facts. As to the dual principle of water supply, if they had any *recherché* system as to quality and quantity of water that was applicable, they might have a separate dual system, but they had heard that the result of softening the water, and bringing in soft water for consumption by a separate system, was that water would be brought in for washing and ablutionary purposes and for baths—for everything in fact which would be benefited by the introduction of soft water—yet in fact, though the benefit would be great, it was obvious enough that the streets could be washed with common water; and, on the whole, he had expressed the opinion that the separation was not worth while, and to that opinion he still adhered. In one district, where an inspector was sent to examine the effects of drinking the Thames water from a place highly polluted with sewage, the people laughed at the idea that they drank water; in fact they drank beer, and beer generally was drunk by the whole of the wage-earning classes. Such was their dread of drinking the water in one case, that when he went to look at a place in London where the finest water was delivered, viz., the Kent water, he was warned against drinking the water on account of the gases from cesspools making it a source of great danger. The reasoning was that the death-rate there, where they had the purest water of all, viz., the Kent spring supply, was higher than it was in other places, and the deduction from that was that the water was positively unwholesome. But it proved to be nothing of the kind, for the people did not drink the water. It was the rarest thing for them to do so; even when a mother went out with her children, she was very careful to provide beer for them, for fear of the danger from drinking the water.

Mr. JABEZ HOGG said it was very evident children did drink the water, and no doubt to that fact was due the increase in the death-rate among the infant population. With regard to the arrangement of the filter-beds shown in the building, no two of them were alike—no two water companies adopted the same size and proportion of filtering

materials; some gave six or eight inches of sand for a surface layer, and others gave four or five. There was no uniformity in the arrangements for filtering water, and that showed that filtration was of far less importance than it was generally supposed to be. The water companies evidently felt that it was a matter of very slight importance whether they gave a filter bed of six or eight inches of sand or four or five feet. One of the readers of a paper had remarked upon the companies compelling people to remove their waste pipes; he should like to ask practical engineers a question upon that point. Water companies were not agreed as to the use of the waste pipes. Some years ago, he removed his own waste pipe, which went into the sewer pipe, and converted it into a surface overflow pipe. Two years ago, the New River Company sent him a compulsory order to remove this pipe, and put in another overflow pipe at the top of the cistern. He had to alter all his fittings at considerable expense, and at the end of two or three weeks he found the effects of the overflow pipe was to inundate his house, for on a fire breaking out in the neighbourhood, during the night, the cistern overflowed, and the water came down the staircases and spoiled his carpets. He expected to get nothing from the water company in the shape of compensation for the damage done by the overflow; nor for the great damage done to the basement by the damp. But for the company insisting upon the removal of old pipes, which had been working efficiently in his house for some years, the damage referred to would not have happened, and the only excuse for removal was that the company was going to give him a constant supply of water; two years had elapsed and the constant supply was still promised. A fifteen minutes' supply at 11 o'clock, and no other supply for the day, unless a fire happened in the neighbourhood, when the water was turned on again, and he was liable to an overflow, unless great care was exercised in the examination of ball-cocks. Then there were, again, dead ends of streets, and dead ends of the

companies' pipes, which greatly polluted our water cisterns, and as one gentleman had stated, when these got emptied, they occasioned a semi-putrescent rush of waters into the sewers, or into house cisterns.

Mr. CHADWICK said there was one point he would mention with regard to waste prevention. In Manchester they had got it down to 17 gallons a head, and in other cases the same thing had been done. But these were cases where the water belonged to the Corporation, and it was the officer of the Corporation who went in to examine, and not of any trading company. That difference was the great reason for the failure of any attempt towards the reduction of waste in London. If things were done there as in Manchester, Liverpool, and other towns, he had no doubt that waste in the metropolis might be reduced even more than was anticipated. They anticipated a reduction of one-third in the waste, and if the matter were under a public authority, who ought to have the control of the whole apparatus, not merely of the mains at the doors, but the capillaried works within the houses, that reduction could be effected, but until they were placed on a public footing there would be no economy secured.

Mr. WALKER had intended to confine his remarks to the subject of waste, but he wished to answer one or two remarks of the previous speakers. A remark had been made about the warning pipes. They were led to infer, because there was no flow from the warning pipe, it indicated a want of supply. As a waterworks manager, he would say it indicated that the fittings were in good order. At the same time it was not necessary for works to belong to a company to have efficient supervision; and to show how these matters were looked after by a corporation, he would read part of Rule 16 of the Reading Corporation Waterworks regulations. "Every cistern shall be provided with an efficient ball-valve and warning pipe, and shall be fixed in such a position as to be easy of access for inspection." If warning pipes were fixed in

such a position that when there was an overflow, or when they indicated that some of the fittings were out of order, and caused damage to the property of the consumer, he would say that the company's officers were to blame for allowing the warning pipes to be fixed in such a position that they would, by overflowing, destroy any property of the consumer. Then, again, with regard to filtered water, the supply with which he had to deal came from a river. He had tried several experiments with reference to filtration, and he had found that filtration took place almost at the surface of the sand. If they had a bed of sand two feet in thickness, they would find, after a few weeks' use, if they let the filter dry, they could lift the film off as if they were drawing a piece of damp paper off a table. He would not say that the thickness of sand should be reduced to a few inches or under two feet, but through even two feet of sand sometimes they would find living things in the mains. Perhaps a consumer would come and make a complaint about finding a fish or an eel in his supply, but it did not follow from finding them in the mains that the water was impure. He thought, however, when they found leeches in the water, they were justified in preventing children drinking it. Much had been said in the course of the morning with reference to cisterns, but as the morning had been wholly devoted to reading papers, and the discussion had been left to gentlemen who were well acquainted with the subject of water supply, he had refrained from saying anything. The remedy he thought was to have a constant supply laid on. If they were to take a bottle of river water that had passed through a filter, to all appearance it would be clear and bright; but put a stopper in that bottle, and seal it down, and in a month or so afterwards they would find there was a considerable deposit at the bottom of the bottle, and to all appearance they would say it was very bad or very impure water. Impure water for public use, he would say, was water that fish would not live in; and water that fish would live in was not impure.

The conversation where he was sitting during the morning, turned on water supply to houses, and a lady said she had had the cistern in her house cleaned out, and the deposit found in it consisted principally of soot from the tiles, but that did not show that the water was impure. Then with regard to the remark as to water supply for fire extinguishing purposes, the diagram on the wall was an answer to that. A dual supply is not required. A town having a constant supply, and the fire brigade arrangements being under the control of the police, they could, in a few minutes after the alarm was given, fix a standpipe, and begin playing on the fire, and if the pressure was sufficient, they could do much in keeping down a fire before the engines arrived. With reference to waste prevention, he believed the best means of effecting that is to have a thorough code of regulations, and to have those regulations properly carried out. Much had been said with reference to Deacon's meters. There were no doubt a good many waterworks managers present, and other persons who must have received circulars, in which it was stated that managers were exceedingly pleased with the efficiency of Mr. Deacon's invention. One gentleman had stated that previously to the introduction of that apparatus there was a waste of 80,000 gallons a day going on in one district. He should think if there was a waste existing in any town of 18,000 gallons a day, it showed ignorance on the part of the engineer or the Board of Directors, and that there must have been great neglect. In reference to that subject, he would read a return with regard to the town he was connected with, viz., Reading, which stated that in 1874, the nett consumption was 47·71 per head per day; in 1876, with an increase of population and an increase of services, it was reduced to 30·24 gross, or a nett consumption of 16·99. But the circumstances which affected one town would not apply to another; some towns had a much larger trade supply than others, and they could not, therefore, draw a fair comparison on that account. In 1884, with a popula-

tion supplied of 52,000, the gross consumption per head during the hot weather was 34·61, and the nett 18·26. This increase was due to the fact that a very great quantity of water was used in Reading for road-making and for new paving works which were now being carried on; and in addition they supplied 130,000 gallons per day to one railway company, also 23,000 gallons for sewer flushing, and in the town there were upwards of 8,430 water-closets. All this was done without waste-preventing meters, and if waste-preventing meters were used, they must increase the cost of management. With all those circulars which were sent, they had not stated anything as to any saving in working expenses, and he considered that to be a very important matter indeed.

Mr. E. K. BURSTAL said he had heard instances of six towns which, under companies' management—although two had recently been transferred to corporations—were the best managed towns in England—Nottingham, Derby, Norwich, Stourport, and Sheffield; and in fact he believed, in two cases, they had been transferred to the corporations because they were so well managed.

Mr. DICKSON said Mr. Burstal had made some observations with regard to the exhibit of the water companies, complimenting them on the admirable collection of curiosities they had shown, but complaining that they had not submitted to the public those apparatus which they considered best adapted to the purposes of the population. He would remind the Conference, however, that when the Commission sat in 1871, the whole weight of evidence tended to show that it was desirable that companies should have the power of inspecting, examining, and approving fittings to be erected in the houses; but, to the surprise of most people who followed the inquiry, the Commissioners, at the end of it, said they felt bound to recommend that no such power should be given, because they feared it would have a depressing effect on inventions and improvements of water apparatus. Consequently, while Manchester had the *power* of approving the apparatus to be used, the London

companies had no such power, and any kind of water fittings which complied with the standard of ordinary intelligence was deemed to be an efficient apparatus. The magistrates of the metropolis were the authorities to whom this question was relegated, and they were very reluctant to fine persons for having a defective water apparatus, if it could be shown that it would do what would in their opinion be ordinarily expected of some such apparatus. The consequence was that companies, knowing this weakness, were obliged to pass fittings which, if they had proper authority, they would possibly be able to exclude. The companies, therefore, were not in a position to bring before the public any exhibit which they could recommend for adoption, for if they did, there would be an outcry on the part of this or the other inventor that his invention was superior, and the companies would incur a great deal of odium in addition to what they at present experienced. With reference to the question of warning pipes, he would remind Dr. Hogg that the regulation in this respect said that the overflow in connection with drains should be removed within a certain time, or at the option of the consumer should be converted into a warning pipe, and that every warning pipe so connected with the cistern should be placed in such a position as to be easy of access and inspection by the company's inspector; and he doubted not the reason of the remonstrance of the New River Company to Dr. Hogg on this point was that the pipe which he placed to his cistern, in substitution of the overflow pipe, was not so arranged that it could be seen by the inspector, otherwise he should not imagine any water company would require a consumer to provide an overflow pipe. In fact, every water company would be glad to see any overflow pipe in the sense of one which took an overflow from a defective valve-cock, done away with. A warning pipe was a very useful thing, if properly placed and connected, as a sanitary convenience as it introduced fresh air to the surface of the water. With reference to the paper on fire extinction, he thought there was rather too sweeping a condemnation of the London

supply, which the writer said was deficient in pressure. It was stated that in London the whole water supply was pumped which would very likely be misunderstood; the author was comparing the cities where the supply was by gravitation with other places where it was pumped. In London, as far as the fire supply was concerned, it might be stated to be by gravitation, because the water was pumped into reservoirs, which formed a head for the fire supply, just as much as in other towns where the supply was by gravitation without pumping. Then the writer stated that the average pressure was quite inadequate for fire extinction without the intervention of fire-engines, and again further on, he said the supply was undeniably deficient. He might appeal to the memory of Mr. Chadwick, who was present at the inquiry referred to, whether the general effect on the mind of the committee was not that the average pressure was quite sufficient for ordinary requirements of the fire brigade. The pressure in any town would scarcely be such as would enable the public authorities to do without engines; in fact, it would be the most injudicious thing for any authority in London to have such a high pressure as to do without engines entirely. He would recommend the author of the paper to inquire of the fire brigade authorities for the results which accrued from the adoption of hydrants in the City of London. He could inform him that at the large fire opposite the General Post-office, there were a set of hydrants provided by firms on their own premises which were found to be of great use, and certain property would inevitably have been destroyed had it not been for those hydrants. Again, with regard to the Kent Company, it was shown before the committee that the pressure throughout the company's district was quite adequate for the purpose of the Fire Brigade if hydrants were provided, but the Metropolitan Board would not provide them until the company said that if they did not they would exercise the power of the Act enabling them to do it themselves, and thereupon they put up a few hydrants which were tried at large fires on the river

side, where they were used without the intervention of steam engines, and the Metropolitan Board has since admitted that the pressure was adequate, and they had recently given an order for 200 hydrants to be erected in different parts of the whole district within the metropolitan area.

Mr. DEACON said he had only heard part of the discussion, and none of the papers, and would not have spoken had he not felt it desirable to throw in his experience against the objections which had been raised to cutting off sewer overflows from cisterns or replacing them by warning pipes. He had been instrumental in giving a constant service to a population of 700,000 or 800,000, in one place, and he believed at much less cost per head than had ever before been found sufficient. The quantity supplied was much less than under the previous intermittent service, and the methods he had adopted were now applied to many millions of persons, both here and in America. In Liverpool, the work had necessarily been done with comparatively little alteration of fittings. There were no such powers there as were possessed by some towns, notably Norwich and Manchester, where the corporations of companies had practically unlimited power to require the removal of fittings and to order any others to be put in. The secret of ultimate success in Liverpool, and in many other places, without oppressive regulations, was the multiplication, by a method often described but not always understood, of the means of detecting actual cases of waste by a given staff of inspectors, and the inclusion of hidden as well as visible waste. Of all methods, that must always be the best which can produce the required result at the least cost, and with the least annoyance to all concerned. Those who still believed in the antiquated method of house-to-house inspection had not tried the more modern method, and were not, therefore, qualified to speak concerning it. The many who had tried it on a large scale were, he believed, unanimous concerning its much higher economy and efficiency. With respect to the difficulty of not getting convictions from magistrates, there was com-

paratively little necessity for going before the magistrates, when the facility for detecting waste was so greatly increased. Persistent cases of waste were soon brought to bay, when the delinquents found that the trouble and expense to them of attempting to evade the doing of what was reasonably required by the officials was not worth their while incurring. The warning pipe was one of the instruments by which they succeeded, and he was exceedingly surprised to hear it suggested that some form of warning pipe should not be used. There was no doubt whatever that, unless you had some overflow apparatus which either made cistern waste a nuisance to the individual or visible outside to the public, that waste would go on to a very much larger extent than would otherwise be the case. It was not necessary to turn to Liverpool, as they were now discussing matters concerning London. The same thing had been done here. In the Lambeth district the waste had been so far reduced that, where the same methods were applied, the consumption and waste, instead of being between 30 and 40 gallons per head, as formerly, was now down to something between 15 and 16 gallons on constant service. If people had all the water they would take under high pressure and constant service, they had all that it was possible to give them. There should be no desire on the part of the authorities to prevent the use of water, but only to prevent deliberate harmful waste. If this were done, sanitary advantages, as he had elsewhere shown, must inevitably follow, as they had followed in Liverpool and elsewhere.*

Mr. MAXWELL said this question of waste was a very elastic one. They talked about getting the supply to under 20 gallons per head, but in some of the American towns it was up to 60, 80, 100, and 120 gallons. If you had a family of four or five, each of whom had a separate bath in the morning, using 40 to 50 gallons each, that

* See final remarks in discussion upon the paper by G. F. Deacon, read to the Society of Arts on the 17th May, 1882.

would soon mount up. He was engineer to a town where the water-works belonged to the corporation, a dead level town. If he were the officer of a private company, it would be his duty, probably, to try and keep down all waste, to have no dribbling taps, and no water running otherwise than for some beneficial purpose; but the health of such a town as Hull depended on the water flowing into the drains, and as they could pay their way very well without being so sparing of water, and as they always had it to spare, he did not set himself so very dead against waste. They did set themselves against it in one way, which he would explain. Inspection was of two sorts; inspectors might go in and threaten and frighten people, but their inspectors did not; they kept all their consumers' valves, and washers, and ball-taps in order, and they found it paid them to do so.

Mr. TARBOTTON, said he wished to say a few words on the general question, and principally with regard to dual supply. In all these public supplies, whether water, gas, or the disposal of sewage, a dual system, as a general principle, was to be condemned. They all knew the practical difficulties attached to these undertakings, and they also knew how very dangerous it was to allow a double system to be in operation. Of course there were exceptional conditions, and there were towns in Germany, and many other places, where it was perfectly easy to supply two classes of water; but in English towns he hardly knew an exception, except, perhaps, certain parts of the metropolis, where it would be possible and safe to carry out and introduce a double system. They knew what plumbers were in large mansions or institutions, and also what they were in small poor houses, and he was quite satisfied that two supplies ought never to be undertaken in London. The same thing applied to gas. You could supply gas at 12-candle power, or 18 and 20, but it meant duplication of services and mains throughout the whole system, and when you examined the amount of capital which had been expended on gas and water undertakings, it would be

found, as a general rule, that the cost of the distributive service was 4-10ths of the whole, and that would have to be multiplied by two if a double system were carried out. With regard to the general question, he believed in the principle of constant high pressure service. They had had a high pressure service at Nottingham for nearly fifty years, without a single intermission, the pressure varying from 40 to 120 lbs. in all parts of the town, which system had been introduced by Mr. Hawksley. With regard to the prevention of waste, in a district which comprised a population of a quarter of a million, they had a very effective system of daily inspection carried out by specially trained men, and by that means they had reduced the domestic supply to a volume of something like 12 gallons per head; the total supply, including manufactories, being under 20. At one time it was something like 55. The same thing had prevailed in some other towns, where a similar reduction had been accomplished by the same means. The fire service was very effective, but they relied in a great measure on the pressure in the mains, which was sufficient to send the water over the highest warehouses and buildings; that, however, was supplemented by an efficient fire brigade.

Mr. SMARTT said he had a miniature farm or garden, by experiments with which he found that sewage water passed through boulder clay lost very little of its nutritious qualities.

The CHAIRMAN said he must now bring the discussion to a close, though several other gentlemen had sent up their names, for only a few minutes remained for him to offer some remarks on the chief points which had been discussed that day. It would be presumptuous in him to attempt to go over anything like the large range of subjects which had been dealt with; but he could not refrain from saying a word or two on the question of the quality of water, which had been one of the most prominent subjects under discussion. They must all regret that the *very* admirable paper of Dr. Odling had not been presented

in extenso in print, and that they had not been enabled to examine the facts upon which he was quite certain the arguments had been based, which had led Dr. Odling to the conclusions he gave at the close of his paper. With regard to some of those conclusions, they would be all of one accord, viz., that the purity of water should, in the first instance, be considered by the chemist in its entirety; that what chemists called impurities did not necessarily relate to unwholesomeness: that, taking the actual proportion of organic matter existing in water, it was so small as to be of no importance in considering the quality of water for potable purposes, and also that organic matter which at one time might have resulted from decay, might possibly have no real importance with reference to the quality of water; that it might exist to a considerably greater extent in what was considered as the most wholesome spring water, than in the water of a stream. Again, with regard to his fourth conclusion, all who had studied the subject of so-called self-purification of water had come to the conclusion that this self-purifying power of a stream was very great indeed, and that the oxygen dissolved in the water, and continually re-absorbed by it—an action favoured by the agitation of the water in its flow—had the power of removing, to a considerable extent by oxidation, the organic impurities with which the stream might have become polluted. But when they came to the last two conclusions at which Dr. Odling had arrived, he must say that, in the absence of the facts upon which they had been founded, they still remained debatable; these conclusions being—that there was an absence of evidence as to the injurious nature of organic matter which might sometimes be found even in carefully filtered waters, and that there was no evidence that disease-producing organisms were developed or propagated in waters so filtered, so as to be prejudicial to life. All who had given any attention to the subject of the influence of water in promoting disease, would be inclined to hesitate before accepting the latter proposition; and they must, therefore, look forward with great interest to

the publication of the complete paper, which would, no doubt, give the facts and reasoning upon which this statement was based. It had been within his experience that water which had been considered as of the very highest quality, and which the advocates of deep wells would unhesitatingly pronounce to be of a high quality, had, after its supply for house use, proved a source of disease. This led him to refer once more to the question of tanks. There had been a much greater unanimity of opinion than on any former occasion with regard to the mischievous results which might arise in consequence of the storage of water in houses. Mr. Hogg had explained that, in hesitating to adopt the statement that tanks or reservoirs were injurious, he did not refer to open tanks, butts, or reservoirs, but to closed tanks, which he looked upon as harmless. Even so far he must confess he did not feel inclined to agree with Mr. Hogg, from the very fact he had already alluded to, that a house supplied with one of the purest of London waters—a deep well water—was visited by disease such as Mr. Hogg pointed out as consequent on the pollution of water by matters connected with zymotic diseases, although the tank was apparently perfectly closed. There was not the least doubt that this was due to the causes insisted on by Mr. Chadwick, that wherever tanks existed there might, unless very great precautions were taken, be a possibility of pollution by gaseous emanations from sources of pollution. This being the case, there could not be a doubt that the constant supply, and the absence of cisterns, were fundamental points in the supply of wholesome water. How far measures could be taken to guard against waste, he must leave to those competent to deal with this part of the subject, by some of whom it had been shown, during the discussion, that, at any rate, considerable advances had been made in this direction. He should imagine that no householder would hesitate, if he desired to obtain a high-class water, to adopt such precautions as might be reasonably within his power to guard against waste, and that everyone would willingly bind himself to use the water

carefully, provided he were perfectly sure of the quality. Even though certain arrangements which had been suggested might be inconvenient or unsightly, there was no doubt the advantage they would secure in promoting the supply of thoroughly pure water at a comparatively moderate cost, would counterbalance any of these disadvantages, in the opinion of all sensible people. They had discussed as far as possible the question of the advantages and disadvantages of a dual supply, partly in reference to the large consumption of water for ordinary purposes, and partly in reference to the application of water to fire extinction, but the question evidently still required much further consideration. There had been one or two advocates of a dual supply; but others had pointed out, and he thought correctly, that very great difficulties existed, which some were inclined to think insurmountable. The distinct supply, on a very large scale, of water of ordinary quality, such as they would not use for potable or other domestic purposes, would involve an enormous outlay of capital, and it would be very difficult to insure the use of such water in a manner which would be really safe to householders. It was gratifying to find that, since they last held a Conference, there had been a considerable assimilation of views amongst those who were formerly much opposed on the chemical aspects of the question. There was now a very considerable concordance of views amongst chemical authorities, and so he believed they would find that, amongst practical men, some of the difficulties which appeared insurmountable would gradually vanish, and that by comparing ideas and experience, they would speedily arrive at a very great advance in connection with the water supply of large towns. He regretted that the special attention which London had received in the discussion had led to very little being said about the water supply of villages or small towns. This was a subject which no doubt required so much earnest consideration that it would be desirable, before long, to have a Conference at which to discuss the subject on the still broader basis of a

national water supply. In connection with this there were several important subjects which had not been exhaustively discussed, such as the question of the value of different systems of wells which were applicable on a small scale with comparative readiness, and the very important question of the extent to which purifying agents could be applied to water for small communities. They knew how valuable had been the results of Dr. Clark's process when applied so intelligently as it was, many years ago, by Mr. Homersham and since by various others, such as Mr. Porter and Mr. Atkins. In some instances, water which it was almost impossible to use for domestic purposes, on account of its exceeding hardness, had become an excellent water by application of this method of treatment. He had personal experience of this, inasmuch as he took part in experiments which Dr. Clark made when he softened water at the works at Plumstead, about thirty years ago, and had since had the supervision of softening works erected for the supply of water from deep wells to the Herbert Hospital at Shooter's Hill. What had been so successfully accomplished at this place, and elsewhere more recently by improved processes, had demonstrated how readily water might be treated when the supply required was comparatively moderate. The same system had even been applied to towns and districts of some considerable size; but the question still remained to be determined whether it would be possible to apply this excellent process upon so large a scale as would be necessary in order to supply London, or the more important districts of it, with softened water. That the Kent Company had hesitated to apply this system to the deep-well water supplied to Woolwich and elsewhere, which was most beautiful and wholesome to drink, but ill adapted to other domestic purposes, seemed to indicate that practical difficulties still existed which had to be encountered, not merely by the application of capital, but by science combined with practical knowledge. With regard to other methods of purifying water, considerable improvements had been effected in recent years in the

application of filtering media, such, for instance, as charcoal preparations, and iron in a more or less finely divided condition. If water were affected chemically by treatment with either precipitating or oxydising, or otherwise purifying agents, such treatment must be efficient in proportion to the amount of surface of water brought into contact with the agent applied. If iron exerted a purifying influence on water, it would obviously exert that to the greatest extent within a given time, if the surfaces of the iron and the water coming in contact were constantly renewed. That this was done to a considerable extent in a filter there could be no doubt, but when a column of water was passed through a column of filtering material, the latter must present channels in parts, admitting of the free passage of the water. By passing through these the water must to some extent escape being purified; but if you took the same purifying agent, and agitated it for a short time with water, you renewed the surface of contact between the water and it continually and rapidly, and so, as a matter of course, effected in a short time what you had to apply a considerable amount of time, and a comparatively very large amount of purifying material, to effect to anything like the same extent by the ordinary methods of purification by filtration. There could be no doubt that the action of charcoal as a purifying agent, quite apart from its action as a simple filtering agent, was much promoted, like that of iron, by constantly renewing the surface of contact between the charcoal and the water, and so he should imagine that filtering on the principle devised by Mr. Maignen, or other filters based on similar principles, would act more efficiently and rapidly than the mere passage of water through charcoal *en masse*. No doubt much had to be learnt with regard to the treatment of water by means of domestic filters, which would always be important in connection with the supply of small communities, and that of groups of people like soldiers on active service. A filter was popularly expected to accomplish two things: in the first place, it simply

strained or clarified water, by separating suspended matter, and a properly-built filter might be relied upon to carry out this operation for a considerable period, until, in fact, the passage of the water was too much impeded by the clogging effect of the impurities deposited in the filter. Secondly, some filters would to a small extent purify water of dissolved matters, but it was important to bear in mind that that power could only be retained by a filter for a comparatively brief period. Many people bought a filter, and having set it up, they did not care much what the source of water was which they used, being satisfied that, by having bought one of the best forms of filter, and drinking nothing but the water filtered through it, they were secure against all evils ascribable to water. But that filter might, and was generally, filled month after month, and even year after year, and was supposed to continue perfect as long as the water ran through it, and was not even suspected of being inefficient until it became actually choked up. This was one of the most dangerous points connected with the application of filters to domestic purposes, and too much stress could not be laid upon it. He begged, in conclusion, to congratulate the Society upon the useful nature of the discussion, elicited by the valuable papers which had been brought before the Conference.

Mr. EDWIN CHADWICK then proposed a vote of thanks to the Chairman, which was carried unanimously, and the proceedings terminated.

The following letter from Mr. W. Whitaker refers to his paper read on the first day (see *ante* p. 364) :—

There having been no time for the authors to reply to the points raised in discussion, I send the following note on what fell from Mr. Baldwin Latham, and from Mr. Kinsey, in regard to the chalk marl on the south of London and

near Petersfield, allowing of the passage of water between the chalk above it and the upper green sand below. In my paper the suggestion that another colour might have to be added to those already used on my maps to separate the chalk marl from the rest of the chalk, is not of universal application ; but refers only to those parts where the chalk marl is so clayey as to be practically water-tight and not water-bearing. The district in my mind was not that on the southern side of the London basin, but that on the northern side, where, for very many miles in Hertfordshire, Bedfordshire, Cambridgeshire, and part of Norfolk, this basal part of the chalk is so impermeable as to throw out water from the permeable bed of hard and somewhat sandy chalk that overlies it. The outcrop of that permeable bed, known as the Totternhoe stone, and which has been largely used in building, is marked by a line of springs the occurrence of which has determined the site of the many villages to be found along the base of the chalk hills from Hertfordshire to Cambridgeshire. The conditions here are clearly different from those that hold on the southern side of the London basin ; but I doubt if in the latter district the chalk marl everywhere allows the passage of water through it, and evidence in this direction is given by the experimenta. drift-way of the Submarine Continental Railway, near Dover, which, driven through chalk marl, was practically dry. To show, however, the varying nature of this bed, as regards water, we need only cross the Channel, to the corresponding experimental works of the French Company, where many springs were met with in the chalk marl. At Dover the only fluid found was champagne, and it is said that this was dry !

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